


## THE

## Religious Pbitofopher:

 Or, the Right USE ofContemplating the W orks of the CREATOR:
I. In the wonderful Structure of Animal Bodies, and in particular, MAN.
II. In the no lefs wonderful and wife Furmation of the Elements, and their various Effects upon Animal and Vegetable Bodies. And,
III. In the moft amazing Structure of the

Heavens, with all its Furniture; DESIGNED
For the Conviction of ATHEISTS and INFIDEls.
The THIRD and Laf VOLUME.
Throughout which, all the late Discoveries in Anatomy, Pbilofophy, and Aftronomy, together with the various Experiments made ufe of to illuftrate the fame, are mof copioufly handied by that Learned Mathematician, Dr. NIE UWE NTYT.

## Crantatea fromt the negitimal, By John Chamberlayne, Efq; F.R.S.

Adorn'd with C U T S.

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L O N D O N:
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Printed by T. Wood for J.Senexin inalisbury Court, and W.TAylor at the Ship in Pater-Nofter-Row. 1719.



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## THE

## Religious Pbilofopher:

Or, the Right USE of the
Contemplation of the Works of the CREATOR, Orc.

## Vol. III.

## CONTEMPLATION XXIV. Of the Vifible HEAVENS.

Sect. I. Tranfition to the World in General, and to the Heavenly Bodies in Particular.

20w O afcend now to that wonderful
 Stracture of the glorious Heaven $S_{\text {s }}$ and to fhew from thence in a molt convincing Manner, to all fuch as ftill doubt whether there be a Creator and Ruler of the Univerfe; there fhould feem nothing more to be required, than to lift up our Eyes, and only to Contemplate the Firmament Vol. III, Yy without
without Prejudice, and therein the incredible Greatnefs of that unmeafurable Space, and of the Lights that are placed in it; and befides, the wonderful Splendor of them all, the particular Influences which the Sun and Moon, among others, have upon our Globe, their unfpeakable fwift Motions, hardly to be comprehended by human Imagination ; and in the whote, the juft and exaft Obfervation of 10 many Laws and Ways to which fuch a Number of Bodies have been fubject for fo many Ages, through fuch vait and unknown Spaces, and with fuch a terribly fwift Motion as far exceeds that of a Cannon Bullet, and without being in the leaftwife confcious thereof themfelves: And this ought certainly to make an Atheift acknowledge, in cafe no Adorable and Powerful Direction had place in all thefe Matters, and thefe Bodies, with refpect to their Magnitude and Velocity, were only moved by Chance, that they might likewife fall foul upon, or run againft each other by the fame Chance; and therefore that it would have been much better for him never to have been born, than to live in a continual Fear, that fomething like this fhould befal the Earth, which is his Dwelling-Place.

## $S_{\text {ес }}$. II. Convictions from the Sight thereof.

And tho' one fhould not carry one's Thoughts fo far, let an Atheift fuppofe (to make ufe of the Emphatical Proof produced by Cicero in his Book of The Nature of the Gods) that from the Beginning of his Life he had been always fhut up in the Cavern of a Mountain, in which he had feen no other Lights than little Lamps, nor no other Colours than thofe of difagreeable Rocks: Now if he had met with an Opportunity of fpying through a Crack of this Mountain or otherwife up in the Air,

Air, that Fire-Ball, fo full of Luftre and Beauty, the glorious Sun moving in the Heavens, and not only enlightening and warming this whole vifible Globe of the Earth, but likewife rendring it fruitful and capable of fupporting both Men and Beafts; and befides all this, fhould fee the lovely Green of Trees and Fields, and the charming Colours of fuch a Number of difierent Flowers; and could he help being exceedingly furprifed and amazed, and forbear thinking how unconceivably Great and Glorious the $\mathrm{C}_{\text {REAT }}$ or of all thefe Things muft be ?

Sect. III. The Sun proved to be bigger than the
Earth by the Eclipfes.
Now how ftrong and irrefragable a Proof foever be drawn from the mere Contemplation of the Heavens, that it muft have been a Great and Adorable Creator by whom thefe noble Bodies, and particularly the Sun, has been made, and by that Means fo many Benefits and Advantages daily communicated to this our Globe; yet there is a great Error which has hinder'd almoft all Men from judging of thefe Matters according to Truth: It is that Childifh Prejudice which caufes us to look upon the Sun to be a Body of the Dimenfions or Breadth of about a Foot, or a Foot and a half at moft.

But thofe who know by the Eclipfes of the Moon, that the Shadow A L Z (Tab. XX. Fig. 2.) which the Sun D G, by fhining upon one Side of the Earth, cafts on the other Side, grows continually fmaller from $\mathrm{A} Z$ to L , and runs out to a Pyramidal or Conical Figure A L Z, the Point or Vertex of which is at L; may, without knowing much of Opticks (whereby the fame is proved) quickly infer, that the Sun DG is much greater Y y 2 than Shadow, being then equal at AMNZ, would be every where, or at M N, as big as at A Z, and always remain fo.

And in cafe the Sun's Diameter were $a a$, fmaller than the Earth A Z, it is plain enough that the Shadow of the Earth would become continually larger towards P O, and farther.

So that Since it appears, by undeniable Obfervations in the Eclipfes of the Moon, that the Diameter of the Shadow at the Diftance of the Moon, is not equal to that of the Earth, nor becomes bigger when farther from it, but that growing continually leffer, it makes the Pyramid AL Z; it will entirely fatisfy thofe that underfand this, that the Sun D G, is bigger than the Earth A Z.

The Knowledge of this may perhaps in fome manner deliver People from the aforefaid Childifh Prejudice, and raifing their Afonifhment, at the Power of their Creator, make them confider the Sun in its true Magnitude. But this will be done much more effectually when they know, that, according to undoubted Aftronomical Obfervations, we may fafely fuppofe the Sun to be above a Hundred Thoufand Times bigger than the Earth. I know very well that this will appear altogether incredible to thofe that are unexperienced in Afronomy; $\mathrm{s} / \mathrm{t}$, Becaufe the Ancients have not allowed the Sun to be more than, 566 Times bigger than the Earth, and fome not fo much. 2dly, Becaufe the Difagreement among the Aftronomers themfelves, concerning the Sun's Magnitude, is the Caufe that their Conclufions have little or no Weight with Ignorant Perfons.

Toremove this fumbling Block, we fhall endeavour, as far as the Brevity of this Difcourfe will permit, to fhew the Certainty of what has been advanced, and tho' we can'c eafily know the exact Magnitude of the Sun, yet it will appear plain enough, that a Hundred Thoufand Globes of the Earth being put together will not be larger than the Body of the Sun. But they who know this by the Principles of Aftronomy may pafs by the following Demonftration, and proceed to SecZ. IV.

Sect. IV. The Magnitude of the SUN proved from Astronomy.

A Brief DEMONSTRATION of the Foundation of the Aftronomical Conclufions about the Magnitude of the SUN.

That the Aftronomers in their Calculations of the Bignefs of the Sun, do proceed upon the fame Principles and Foundations, as the Geometricians in meafuring the Heighth of a Tower, a Hill, or the like, is obvious to all that underftand any thing of Mathematicks. For which caufe we may be equally certain of the Conclufions of the former, as of the latter, provided that the Apronomers can make their Obfervations as jufly and accurately as the Geometricians.

To prove this Affertion a little more clearly :
I. They take the Semi-Diameter of the Earth A B (Tab. XX. Fig. i.) for an Unit, in order to determine the Sun's Magnitude B G, with refpect to the fame.
11. They
II. They obferve, after different Manners, (which we fhall not here defcribe) the Angle A C B, which is made at the Center of the Sun C, and takes in the half Diameter of the Earth A B. This they call the Angle of the Parallax, becaufe, if we look along the Lines A C and BC, which make this Angle (and confequently from the Superficies of the Earth A, and from its Center B) to the Center of the Sun C, the faid Center C, feems to cover the Point I to thofe that look at it from $A$, and the Point $F$ in the Heavens $K L$, to fuch as look at the fame from B. This Difference of Sight they call the Parallax ; and forafmuch as the Angle A BC is thereby determin'd, they are us'd, for Brevity fake, to call this Angle the Parallax : And when they have found this Angle ACB at any. Heighth of the Sun above the Horizon, they compute how much it amounts to when the Center of the Sun C is in the Horizon AI; and this they call the Horizoital Parallax.
III. This Angle was firft?
obferved from the Ancients 03 Min. oo Sec.
down to Tycho Brabh', to be about

But by Longomontanus, a Di- $\}$ or Min. 40 Sec.
iple of Tycho Brabé, reduced to fciple of Tycho Brabé, reduced to
And Lafty, By Kepler after various Obfervations farther or Min. 00 Sec. reduced to
IV. Afterwards another Method of Obfervavation being found out, which was not liable to fo great Miftakes as the former, to wit, by the Moon's Diftance; Ricciolus has found that the aforefaid Angle- does not exceed 30 Sec. or half a Minute.

And this is alfo counted a great Conceffion, fince, according to Mr. Whifon, it does not exceed

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seed 25 Seconds, 10 Thirds. And Wendelinus brings it yet down to is Seconds.
V. There is another Method brought into PraCtice by Monfieur Caffini and Monfieur De la Hire in France, by Mr. Flamfead in England, and other great Men elfewhere; to wit, by Tclefcopes arm'd, with Micrometers, whereby, without any Danger of falling into fo many Miftakes, the faid Angie A CB. may be obferv'd with the utmoft Exatnefs, in cafe it cati bear, by reafon of its Smallinefs, any Determination by us that dwell upon the Earth.
From whence the faid Angle is computed by Flamffead (vid. Whifon. Pralect. Pbys. Matbem. p. 276.) by Caffini, (vid. la Hive's Tab. Afron. p. 8.) by Sir-IJaac Newton, (vid. Gregory Afron. p. 336.) to amount to but to Seconds.
VI. From all which 'tis plain, that in Proportion as the Means have become more certain, and the Inftruments of Meafuring more exact, it has been obferv'd, that the Angle ACB of the Parallax of the Sung has conftantly grown lefs and lefs.
And therefore that there abovemention'd Difficrences that have occur'd among the Aftronomers, have only proceeded from the Moderns ufing better Methods and more exact Infruments than the Antients; but they are by no means to be accounted Difagreements, as fome unskilful Perfons have called them, fince the Antients have only fhown thereby how far they had attain'd, and the Moderns, how much farther: And this is the more remarkable, becaure the faid Differences have only been found between the Antients and the Moderns ; but fo far as they occur between Antients and Antients, and Moderus and Moderns that have made ufe of the fame Methods and Inftuments, they are hardly worth the naming.

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VII: Now
VII. Now to proceed. Since Aftronomers have found in the Triangle A B C the Side A B or the Semidiameter of the Earth, with the Angle of the Horizontal Parallax of the Sun A C B ; and knowing that the Angle $\mathrm{BA} C$ is a right, when the Center of the Sun $C$ is in the vifible Horizon A I, they have found in this Triangle, two Angles and one Side, wherefore by Trigonometry, they may find out the Line B C, or the Dittance of the Sun from the Earth.
VIII. Now this Diftance BC of the Sun frem the Earth being known, which is likewife one Side of the Triangle BDC, they fill feek for for two Ang:es in the fame, they being here neceflary to compute the Semidiameter of the Sun DC.
IX. To find this, they obferve with their InAtruments (which, by the way, exceed very much in Exactnefs thofe of the Antients) the Angle DBG containing the whole vifible Breadth of the Sun, and this they term the Apparent Diameter of the Sun.

The half whereof is the Angle D B C or the Apparent Semidiameter of the Sun, fo called, becaufe it contains the half of its Diameter.
X. There has not occurr'd, in the Courfe of Ages, fo great a Difference in this, as in that of the Parollax ; and confequently likewife according to thefe three times which we have remark'd among the Obfervers before about the Parallax, (when the Sun is in its middle Diftance, that is, between the fartheft from, and neareft to the Earth) the apparent Diameter of the Sun, or the Angle D B G is computed by
Ptolomy, to be- - 31 Min. 20 Sec. Copernicus, at about—— 32 Min. 45 Sec . Tycho and Longomontanus - 31 Min. -

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Ricciolus - 31 Min. 56 Sec.
Huygens - 30 Min. 30 Sec.
Newton, who much approves?
the Oblervations of Caffini> 32 Min . 15 Sec .
and Flamfead -——S
La Hire, about - 32 Min . 11 Sec.
XI. So that the higheft Computation of the apparent Diameter amounting to 32 Min. 45 Sec. and the loweft being but 30 Min . and 30 Sec . the Difference is no more than 2 Min. 15 Sec. the half of which being taken for the Angle DBC, produces only a Difference of $\mathrm{I} \frac{1}{8}$ Min. that is, about $\frac{1}{15}$ Part of the whole.
XII. Whereas the greateft Parallax being of 3 Min . and the fmaileft but of 6 Sec . the former is above 30 Times bigger than the latter, as we have fhewn above by Numb. III, IV, V.
XIII. And from hence it is manifeft, that the Variety of the Obfervations, in the apparent Diameters, may produce fome, tho' but a very fmall Difference ; but in the Angle of the Parallax, it will occafion a very great one in the Magnitude of the Sun.
XIV. Finally, forafmuch now that in the Triangle DBC, is found the before-given Side E C, or the Diftance of the Earth, and the half apparent Diameter of the Sun, or the Angle D BC; and moreover, the Angle B DC being a Right Angle, becaufe the Line B D touches the Circle D O G at D ; it follows, that in the faid Triangle $\triangle$ B C, there are found two Angles and one Side, whereby the third, DC, or the fought-for Semidiameter of the Sun may be found.
XV. We might now, afrer this manner, from thefe and the preceding Conceffions, compute, firt the Difance of the Siun from the Earth BC, and afterwards the Bignefs of its Diameter D.C. But

744 The Religious Pbilofopber. But fince our View here is only toflew the Magnitude of the Sun, and the Difference thercupon between the Old and Modern Aftronomers, but not fo much to enter into any Difcuffion of the Diftance thereof, we fhall make ufe of a more concife Method, which is neverthelefs attended with a Mathematical Certainty, and will be obvious to fuch as are experienced in Geometry.

And this confifts in the following Proportion, or Rule of Three ; in which we flall ufe the Angles ACB and DBC in the fead of their Sines, which indeed would be moft agreeable to Geometrical Exactnefs; but becaufe there refults no confiderable Difference from it, and yet the Calculation is much more convenient, we fhall ufe it as other Aftronomers have done. And thus it proceeds :

As the Angle A. C B, or, the Horizontal Parallax of the Sun, is, to The Angle D B C, or the apparent Semidiameter thereof; fo is The Earth's Semidiameter A B, to The Sun's real Semidiameter DC.

And this Rule does not only obtain with refpee: to the Sun, but likewife to all other Heavenly Bodies whatfoever.
XVI. So that according to Tycho, taking the Parallax 3 Minutes, and the half apparent Diameter $15 \frac{1}{2}$ Minutes, the Semidiameter of the Sunis greater than that of the Earth A B,

And thefe Numbers being cubed, (forafmuch as Spherical Bodies?
are to each other as the Cubes of $>138$ times. their Semidiameters) the Sun is bigger than the Earth -
XVII. According to Ricciolus the? Parallax 30 Seconds, is to the apparent Semidiameter 15 Min. 58 Sec . as 30 to 958 Seconds, or 1 to $31 \frac{1}{5}$; $\} \quad 31 \frac{14}{5}$ times. and confequently the Semidiameter of the Sun DC is greater than that of the Earth A B

This being multiply'd cubically,? makes the Globe of the Sun bigger 31000 times. than that of the Earth above - -
XVIII. According to Sir Ifac? Newton, the Parallax ro Sec. is to the apparent Semidiameter $16 \frac{1}{8}$ Min. as Io Seconds to $967 \frac{1}{2}$ Seconds; and $96 \frac{3}{4}$ times. confequently the Sun's Semidiameter is bigger than the Earth's - -

And this being multiply'd cubi-) cally, the Body of the Sun exceeds $\$ 900,000$ tim. that of the Earth about
XIX. Finally la Hire's Proportion? requiring 6 Seconds Parallax, they are to 16 Min. $5 \frac{1}{2}$ Sec. apparent Semidiameter, as 6 Sec. to $965^{\frac{1}{2}} \mathrm{Sec}$. or $\} 160$ times. I to $160 \frac{1}{2}$; accordingly the Semidiameter of the Sun is greater than that of the Earth - _-

And according to the Cubical) Multiplication, the Sun exceeds the $4,000,000 t_{i m}$ Earth's Magnitude, at leaft
XX. From all which compared with one another we may gather,

Firft, That the Semidiameters of the Sun have increas'd from full Five, or hardly Six ; firt to full 3 I , afterwards to full 96 , and lafty, to 160 Semidiameters of the Earth; which, to thofe that are not much vers'd in thefe Matters, fince the the Numbers are not great, may feem probable enough.

Secondly, But that the Globe of the Sun itfelf fhould grow from hardly 140 Magnitudes of the Earth, firt, to 3 rooo, and afterwards on a fudden to 900,000 , and laftly, to the Size of four Millions of Times greater than the Globe of the Earth, is fuch a furprizing thing, that they who are not ufed to thefe kinds of Calculations, muft needs judge it impoffible, and think that altho' all that has been faid about the Semidiameters were true, yet this would appear a Miftake in Aftronomy: But every one that underftands Geometry knows that one is as fure as the other.

So that we now fee finaily, that this Increafe and Difference of the Sun's Magnitude, manifefting itfelf in the Sequel of Time, was principaliy and montiy occafion'd by the continual Diminution of the Angle of the Parallax, fince the fmall Diverfity in the apparent Semidiameters might indeed contribute fomething, but yet very little thereto. But its amazing Magnitude is now particularly to be afcribed to the Cubical Multiplication of the real Semidiameter thereof.
XXI. Since therefore all that has been advanced, carties along with it a Mathematical Certainty in the manner of computing, it remains only to be inquired, whether the lateft Aftronomers have likewife rightly obferved that the Angle of the Parallax is fo fmall, which we flall leave to the Study of thofe that think themfelves con-
cern'd
cern'd therein; forafmuch as the comparing the three Ways that were in Ufe from the Times of the Ancients, to Tycho Brabé, and from him in the laft Age by Ricciolus, Wendelinus, and others, and now by Meffieurs Caffini, Flamflead, and la Hire, would prove too great a Digreffion, and take up too much room here.

This is certainly true, and obvious to all that underftand the Science of Aftronomy, that, the Antients, according to their own Confeffion, could hardly be certain to a Minute in their Calculations of the Heavenly Bodies, even with their largeft Inftruments; and that the following Methods have had great advantages above the former, both in proceeding more certainly, and in coming much nearer ; becaufe that the Angle, which was neceffary to them for computing the Sun's Diftance, was fo much greater, comprifing the whole Space between the Moon and the Earth, which is about fixty Times as large as the Semidiameter of the Earth, of which the Antients were obliged to make ufe, which renders the Miftakes of the latter in their Obfervations fo much fmaller than thofe of the former. But the Moderns, by the help of their Telefcopes and Micrometers, feem to have brought this Science of Aftronomy to as great a Perfection as it is poffible for Men to do, making the Firmament itfelf ferve them for a Quadrant by the means of the afore-mention'd Inftruments and proper PendulumClocks; and fo, with no lefs Certainty than the former, they are able to make their Obfervations to a few Seconds.

Sect. V. It may be fbewn, with fufficient Ceriainty, that the Sun is above $\mathbf{1 0 0 , 0 0 0}$ Times bigger than the Earth.

But if the Parallax of the Sun does ftill remain immenfurable to thofe Obfervers that can meafure every thing with fo much Exactnefs, efpecially if they endeavour to meafure it about the neighbouting Planets, Mars and Venus, which (if their Diftance alfo do not hinder) have Pa rallaxes much greater and more capable of Ob fervation, and then make their Calculation of the Parallax from the Sun's and Planets. Diftances, (the Ratio whereof is better and fufficiently known to them) it may be inferr'd, that it confifts in a very few Seconds or lefs, if they obferve and difcover it after this Manner. And therefore that we may conclude upon juft and true Principles, that altho' thefe Magnitudes which the prefent Aftronomers do afcribe to the Sun, can't be fo nicely determin'd, by reafon of the Smallnefs of the Parallax (as all of 'em, even the chiefeft, allow, and whereof I could produce many Proofs) neverthelefs the fame muift be unconceiveably great. And in cafe we flould not admit of the 160 Semidiameters of la Hire, and confequently of the Magnitude of the Sin abore four Hundred Thoufand times bigger than the Earth, yet we can't think thofe of Mr. Huygens fo much to exceed the Truth, who makes the half Diameter of the Sun equal to iro of thofe of the Earth, and its Magnitude confequently 133 , ion more than that Earth ; which as, it is eafy to compute, does rerequire a Parallax of eight, or near nine Seconds.

Or we may come yet nearer, and take the Calculation which Sir Ifaac Newton makes ufe of in his Theory of the Moon, which fuppofes the Sun's Semidiameter to be $96^{3}$, and its Magnitude to be 900,000 Globes of the Earth. Yea, if we take that of Flamflead and Horrox, of about 12 Se conds (vid. Newton Princ. Mathem. p. 414.) which is twice as large as Mr. La Hire's; we fhall find yet more certainly, that no confiderable Error is committed in afcribing too great a Magnitude to the Sun, tho' that includes in its Semidiameter above 80, and in its Magnitude above 500,000 times that of the Earth.

Wherefore fuppofing (as we have done, Sect. III.) that the Sun is 100,000 as big as the Earth, we may be fufficiently affured, that we rather make it too fmall than too great ; fince the Parallax in this Cafe of about $2 r$, is at leaft bigger than 20 Seconds, and admitting with Sir lfaac Newton, the apparent Semidiameter to be $10_{8}^{1}$ Minutes, we find the Sun's real Semidiameter to be barely $46 \frac{\pi}{2}$. And that no Error is committed here in allowing too much to the Sun, appears from hence, That the Obfervations (as Sir IJaac himfelf owns in the Place above) of Kepler, Ricciolus and Wendelinus don't allow the Parallax to be much greater than 20 Seconds; tho' they have not us'd the accurate Method of Caffini in their Obfervations, which renders this Parailax yet much fmaller.

Again, becaufe (as appears by Sect. IV.) Wendelinus himfelf, after his Method, makes it 15 Seconds, which is fo much lefs than 20.

Iafly, The Teftimony of the fo often prais'd Sir Ifaac Newton, is of great Weight in this place, who making the Parallax to be 20 Seconds, fays, That he choofes rather upon that Occafion to make it too big than too little; whereby he daes

From whence then it follows, that the Difagreement between the firft and the laft Aftronomers does not prejudice the Truth of the Conclufions of the latter, about the determining the Sun's Magnitude ; and that it is not too large a Conceffion to allow it to be at leaft 100,000 times as big as the Earth.

S ec t.VI. Convictions from the foregoing Obfervations.
$C_{A N}$ it now be imagined, that fuch a dreadful Globe of Fire, which is above 100,000 times bigger than our Earth (and one might more truly fay above a Million of times, according to the aforefaid Demonftration) has been produced by mere Chance, and for fo many Ages continued to difcharge thofe great Functions, of which ail the Inhabitants of the Earth are daily fenfible? And can any one perfwade himfelf that a Sea of Fire, of foaftonifhing an Extent, could have been contained within its Bounds, and in the Order and State we find it in, without the continual Direction of a great and wonderful Power and Wifdom ? Whereas there is no Matter known to Mankind, which with refpect to us operates with more Fury, and, if it be in any Quantity, more ungovernably than Fire, of which there comes down to us daily (as the Burning-Glaffes prove) fo much from the Sun, cither in, or with the Light thereof. And ought not the Hypothefis, that Chance, (or fomething elfe that is entirely ignorant of its own Actions, is the productive Caufe of the Sun) make evcry one, even the boldeft Atheift himfelf, live in a perpetual Fear; that by fo continual a Motion and Raging of fucls an flamed Particles, or that fometime or other, by the Defcent of a much greater Quantity at once of this Matter from the Sun, along the fame Way in which its Rays proceed at prefent, might fet every thing on Fire upon the whole Globe ; or that the Sun having confumed the Food of that Fire, might change its Nature, and ceafe to communicate its Warmth and Light to us; by which Means the whole Earth would be turned into the moft difmal Dungeon that any one can poffibly conceive. How much more eafie then and happy do thofe Men live, who acknowledging the Maker thereof for an Almighty God, and their Gracious Benefactor, know that every thing, and that even this dreadful Globe itfelf, of Light and Fire, can only fir and move according to the Good Pleafure of him that is the Lover of Mankind ; and who, to deliver us from fuch a wellgrounded Apprehenfion, has declared exprefly in his holy Word, Gen. viii. 22. That while the Earth remaineth, Seed-time and Harveft, and Cold and Heat, and Summer and Winter, and Day and Night Sball not ceafe; which Promife has been made good for fo many thoufand Years.

## Sect. VII. The Sun's Diftance from the Earth.

Now if we pafs on from the Magnitude of the Sun (of which I hope thofe that underftand what has been already faid are fully convinced) to its Diftance from the Earth, to the end that we may likewife therein rectify thofe miftaken Notions, which even from our Childifh Years we have conceived about it, and which we can fcarce fancy to be more than the Space of a Mile from us, an unlearned and unexperienced Perfon will not be lefs aftonifhed than he was before, when he hears

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us declaring, that we do not make too large an Allowance for the Sun's Diftance, if we maintain for a certainty, that it amounts to above 1000 Semi Diameters, or Thicknefs of the Earth.

That the Sun is very far from this Globe may be proved by the Sun-Dials and otherwife, which we fhall now pafs by, only fhewing, as we have done before in Sect. IV. that the Difagreement of Aftronomy, with refpect to the various Diftances of the Sun, are only occafioned from hence, that the Moderns are furnifhed with fo much better Inftruments or Methods for obferving the Sun's Parallax than the Ancients; fo that the fmaller this continually appears to be, fo much the greater is the Sun's Diftance from the Earth.

To fet this Matter in a clearer Light, for the Benefit of thofe that are not skill'd in Aftronomy.

Let the Semidiameter of the Earth, A B, Tab. XX. Fig. 3. (as in Sect. IV. Numb. VII.) be taken for an Unir, the Angle of the Horizontal Parallax of the Sun A CB in the Triangle ABC A, being likewife known by Obfervations: Then, fince BAC is a Right Angle, the Diftance of the Sun from the Earth, or from the Line BC, may be eafily found by Right-lin'd Trigonometry: This Operation will be readily perform'd by fuch as only underfand that Way of Computing.

Suppofing then A C B to be the Angle of the Parallax:
With Tycho Brabé of three Minutes,? we find the Diftance BC to confift of Semidiameters of the Earth to the NumII50


[^0]With Newton, Cafsini, ©゙c. of $10 \mathrm{Se}-\} 20,000$
With Huggens between 8 and $9 \mathrm{Se}-\}$ conds,

And with La Hire of but 6 Seconds,? to full

And if (as has been done before) we? fuppofe the Sun to be 100,000 times bigger than the Earth, the Parallax ACB will be about 20 Seconds (computing the apparent Semidiameter of 10,000 the Sun to be $32 \frac{1}{4}$ Minutes) and the Diftance of the Sun from the Earth will amount to Semidiameters thereof,

Now fince we can be affured from the fo exact Obfervations of the greateft Modern Aftronomers, that the Parallax ACB is not more than of 20 Minutes, we cannot conclude with the fame Confidence as a Geometrician can meafure the Diftance of any two Places on the Earth, how great the true Magnitude of the Sun, and how far its Diftance is from us; but it may be concluded by a Geometrical Certainty, beyond all manner of doubting :

Firft, That the Sun is ore bundred thoufand times as big as the Earth.

And, Secondly, That its Diftance from us is not lefs than ten thoufand Semidiameters of the Earth.
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SEct. VIII. Convictions from the foregoing Obfervations.

No w fince it is indifputably true, that if the Sun had been placed much nearer to the Earth than we find it, nothing lefs could have been expected than a Total Conflagration thereof; and in cafe it had been much more remote, the Earth would have refufed to produce its Fruits for the Support of thofe that dwell upon it. Can any one imagine again, that it is without Defign, that this great and terrible Fire among fo many numberlefs Places that it might have poffeffed in the great Space of the Univerfe, with refpect to the Earth, Thould be fixed juft there only, where it can caufe fo much Good and fo little Harm to this Globe? Now if fo unhappy a Philofopher (who maintains that the Sun has by meer Chance only acquired juft that Place which is fo ufeful and advantageous to the Earth, and all that is upon it) be a Mathematician, let him compute how many Places (in which the Sun might have been placed by the fame Chance) are to be found in the vaft Convex of the Starry Heavens, and how many thoufand to one it would have been, but that the Sun might have been fixed in one of ${ }^{\mathrm{J}} \mathrm{em}$, where it would have been entirely ufelefs to the Earth.

> Sect. IX. The Earth for Conveniency Jake Juppofed to ftand fill.

This feemed to be fufficient to Cerve for a Conviction to fuch as ftill doubted of the Wifdom of the Maker. But fince Cuftom, that feems to cloud out Reafon with Stupidity and Infenfibility, caufes moft Men to look upon this furprizing Wonder, like the Beafts without Attention, we
muft advife all thofe who ftill find themfelves but little affected by the common Notices of what they fee daily paffes in the Sun, briefly to contemplate with us a few Particulars thereof, with refpect to the Earth, in which (we here declare once for all, that) we defign to ufe the fame manner of Speaking and Figures that are agreeable with the Notions of Tycho Brabé, and are adapted to thofe Globes, by which a quiefcent Earth and a Sun, moving about it are expreffed. Thofe that embrace the other Hypothefis with Copernicus, namely, that the Earth moves about the Sun may keep the fame Meaning, and adapt it to their own Opinions, as they mult do in the moft, if not in all the Works of the greatef Aftronomers; which, tho' they defend the Opinion of the Earth's Motion, yet in their Calculations concerning Sphericks, or the Circles and Angles which they make, do likewife make ufe of the fame Figures and Expreffions as are founded upon the Immobility of the Earth; as is well known to thofe that have read their Books, and even the Writings of Copernicus himfelf.

Sect. X. The Sun's Diurnal Motion.

Now if any Body were to have his Dwelling upon the Globe of the Earth $p e m f$ Tab. XVI, Fig. 1. and would make himfelf and all other Men happy, would not his firf Care be (in order to avoid living in perpetual Darknefs) that the faid Globe fhould be enlighten'd? Now this is performed by the Sun (for Inftance) at E .

But when this is done, if the faid Sun E ftood always immoveably over the Point $e$, it would be there always Day, and exceeding hot; but on the contrary it would produce a perpetual Night and continual Cold at $f$, both which would be
very inconvenient ; forafmuch as in the laft Cafe, tho' the Fertility of the Earth were not thereby diminifhed, yet all Pleafure; and in the firft Cife too, our mof agreeable Reft would be obffruted.

To prevent all this therefore, it feemed again neceflary, that this Sun fhould move round the Earth in fuch a Circle as ETFSE, in order to enlighten the fame, and render it fruitful on all fides, and not to ftand always fill againf one part of it ; now this happens by the fame Sun's moving round the Earth every twenty four Hours,

> S e c t. XI. The Sun's Annual Motion, Declenfon, and the Seafons of the rear.

Bu t now altho' the Sun fhould daily enlighten and warm the Earth, yet if it were not to move in the aforefaid Circle E T FSE, this ill Confequence might again be expected from it, namely, that every thing upon the Earth, within the Segment of the Circle ef, would be fcorched by its Heat ; and other Parts of the Earth upon which the Rays of the Sun fell more obliquely, would be render'd barren by Cold. Wherefore, that the greateit part of the Earth might not remain ufelefs, 'twas requifite again, that the Sun in its Circulation fhould be ferviceable to more parts of the Earth; and this again we fee performed by the Sun, when it recedes or declines from the Equator EF on both fides, to A Northward, and to C Southwardly, whilft it always moves in the Citcle AY D, which the Aftronomers call the Ecliptic, or Sun's Way. In this Circle it moves daily about one Degree, or the $360^{\text {th }}$ part of a Circle from the Weft to the Eaft, whilft in the fame Space of Time it circulates from Eaft to Weft at an equal Diftance from the Equator E F
of which circular Motions the two extream ones, $A \cdot B$ and CD, are here defcribed; the laft of which it performs in one Day, and that in the Ecliptic AY D, in 365 Days, or in a Year ; and it is this Diurnal Motion that produces Day and Night, and the Annual, the four Seafons of the Year : So that for Inftance, 'tis Summer upon thofe Parts of the Earth, $a$ and $g$, when the Sun is at A in its Way AYD ; and Winter when the Sun is at D; and Autumn and Spring when it is upon either Side of the Globe, in the middle between $A$ and $D$.

SEct. XII: The great Ufe of the abovefaid Motions.
Now by thefe Motions, befides the preventing thofe great Inconveniencies, which would furely come to pafs, if one continual burning Seafon, or an all-congealing Cold fhould always prevail in the fame Region of the World; we find that moft of the inhabited Places of the Earth are enlightned and warmed, according to the Manner and Meafure that is moft agreeable to the Nature of the People and Fruits that belong to it : This Diverfity of Seafons, and Diftribution of Heat and Cold, being alfo the Caufe that fome Lands are difpofed and adapted to produce Spices, and fome particular Kinds of Fruits, and other Countries others; whilf in the mean time this general Benefit is enjoyed by all Mankind, tho' difperfed over the whole Face of the Earth, by the Means of Trade and Shipping, by which every Nation may abound with thofe Commodities that are not the natural Produce of its own Land.
$\mathrm{Sect}_{\mathrm{e}}$. XIII. Convictions from the foregoing.
Before I proceed any further, let me ask thofe Philofophers, who deny the Wifdom and Goodnefs of the Supream Director of all things, Whether upon feeing any Royal or Princely Garden, they would ever pretend to fay, that no Art nor Method had been ufed therein by the Gardener; tho' they fhould obferve, that in order to caufe thofe Plants to grow, which could not bear the Coldnefs of that Climate, Glafs-Cafes, and Places with Stoves and other Conveniencies, had been prepared to make 'em enjoy as much Warmth as poffible; whilf on the other hand, Arbors and fhady Places were provided for other Plants that could not bear much Heat? And whether they would not be convinced upon feeing the grear Variety and ingenious Difpofition of the Plants, Flowers and Fruits in fuch a Garden; that it was not Chance, nor an ignorant Caufe, but the Skill of a judicious Director, which had exerted itfelf in all thefe things, and whofe Defign was to caufe the Mafter of the Garden by fuch a coftly Apparatus, and by contriving fo many different Degrees of Hear, to reap the Benefit of his Labours, and to enjoy the Refrefhment of thofe Fruits which his own Climate and Air were not able to produce?

And can any one that is admitted to contemplate the Agreeablenefs of fuch a Garden, tho' he fhould not fhare in the Fruits thereof, think himfelf obliged to thank the Owner for his Goodnefs, in fhewing him the Secrets of his Art, and the wonderful Ufes of the Plants; and yet be no ways affected with the Goodnefs of the Great Creator of to glorious a Body as the Sun is; by the Warmth of which, the whole Earth is turned
into a Pleafure-Garden and a fine Park, as may appear in Tab. XVI. Fig. I. where the Torrid Zone, $a, b, c, d$, reprefents the Orangery, or Place in which thofe Fruits that require the greateft Heats are produced; whilft others, that require a more moderate or even a cold Air, do meet with the fame in the two Temperate Zones, $a, g, b, b$, and $c, d, i, k$, or even farther towards the Poles in the Frigid Zones, $g, p, n$, and $i, m, k$, as far as the fame remain fruitful. Thus we fee, that there is not only a particular Climate appropriated to fuch various Sorts of Plants and Trees, but that which renders the Obligation that all Men lie under to the adoreable Director of all thefe things ftill greater, is, that his bountiful Mercy does not only difplay therein a wonderful Wifdom even to the cloying with Pleafure thofe that feek for the fame ; but likewife, that the Fruits produced thereby feem to be made for no other Purpofe, befides the Honour of the Creator, than for Medicines to Men in their Sicknefs, and. for Food and Refrefhment to thofe that are in Health; and in general, to render them happy in innumerable Inftances, in which they are fenfible of their Ufe and Convenience.

Sect. XIV. and XV. The Morning and Evening Twilight.

Besides what has been already flewn to be fo wonderful in the Direction of the Sun in its daily and yearly Courfe, let an Atheift judge again, whether it is without a determinate End and Purpofe, that the Rays thereof paffing from a thinner into a thicker Medium, are refracted and turned away from their true Courfe, in order to produce the Twilights of Evening and Morning ; whereas otherwife, upon the Setting of the Sun
in all Places, a bright Day would be immediate: ly changed into a Pitch-dark Night? And it may be eafi y perceived, that it is fo ordered on purpofe to be ufeful to Men, the Organs of whofe Sight would be very much prejudiced, if the Tranfition from much Light to much Darknefs were made all at once: But they that would be more fully informed in this Matter, need only look back to what we have faid in the 17th Contemtemplation about it.

That which may be farther obferved here, is; with how much Reafon God to convince $70 b$ of the Narrownefs of his Underftanding, has taken a Proof thereof from this Refraction of Light in the following Words; Chap. xxxviii. v. 12. Haft thoue commanded the Morning fince thy Days? And caufed the Day Spring to know his Place? Which laft words are tranflated by Pool and others. Do you know perfectly the Place of the Twilight ?

To make this more intelligible to thofe that are unexperienced in the Mathematicks, we have fhewn above, in Tab. XIV. Fig. 3. that the Sun A being under the Horizon E Y, and cafting its Rays A H upon the Air at H , the faid Rays do not proceed directly, and in a ftrait Line to $\mathbf{D}$; but by being inflected, and making an Angle A HF, they are turned afide to $F$, and refracted or broken at H , and thereby produce Day-break or T wilight to thofe that live at $F$. Now it is known to every one by numberlefs Experiments, that according to the greater or leffer Thicknefs of the Air, which varies in different Places, and in the fame Place too, at different times, for many Reafons, the Refraction does -likewife differ : And therefore, that the Twilight, with refpect to the extreameft Parts where it is feen upon the Earth, or in the Air, cannot be determined by any Body; fo that the faid Quettion feems to carry this Meaning along
along with it. Didyou ever truly underftand the di ferent Thickness of the Air, both in your own and other Climates of the World, or the greater or leffer Refraction proceeding from thence, and coneequently the Variations of the Morning and Evening Twilights, which are the Refult thereof ; or bave you any Command or Direction over it? To which Propolition no Mortal will ever be able to return any other Anfwer, than that this has always been myfterious and impraAticable to him ; to convince holy Yob whereof, was the Defign of God.

Befides what has been juft now faid, there may be ftill added thefe Reafons, why 'tis impolfible for Men to know exactly the Place of the Twilight : Firf, Becaufe it feems neceflary to be fuppofed, that the Sun is encompaffed with a kind of an Atmofphere, or Circle of Vapours (as the Earth is furrounded with Air) which upon the Account of the Sun's Nearnefs, does always fhine, and is enlighten'd with the Fire thereof. Secondly, That the Sun fhining upon the Parts or Vapours of the Air, the Rays are fent back from fome of 'em, as it were from a Looking-Glafs by Reflexion, to the People who begin already to enter into Night ; both which contribute very much to the Production of the Morning and Evening Twilight : See concerning this, Gregory's Aftronomy, P. 127. where that great Mathematician (as if he intended to corroborate our Interpretation) ufes the following Expreffion : For the $\rho_{e}$ Reafons the Bounds or Place of the Morning and Evening Iwilights are not fo certain: Befides which, he alledges feveral other Caufes of this Uncertainty.

> Sect. XVỊ.

## S $_{\mathrm{Ec}} \mathrm{T}$. XVI. The Weaknefs of our Conceptions.

Now forafmuch as all the great Services which the Sun renders to Men, Beafts and Plants, are not to be number'd; forafmuch as we fee them daily renewed; forafmuch as if we had been blind before, or remain'd always in Darknefs, we fhould be ftruck with Wonder, and as it were tranfported at the Glory of the Sun's firf Appearance. I have ofren ftood amazed, how it was poffible, that not only the Atheifts (who ad herein according to their Principles) but likewife others that acknowledge a God, and that pretend to worfhip him upon other Occafions, are fo little affected with all the Advantages that accrue to them from the Sun: For inftance, how few are truly thankful for this great Benefit, that God caufes the Sun to rife in the Morning and enlighten the World, and to fet in the Evening and produce the Night, by the Shadow of the Earth, in order to give Reft to all Creatures that have been tired by the Labour of the Day; and fo in other Matters.

But particularly even thofe who are now entirely convinced of the Magnitude of the Sun, and its great Diftance from the Earth, by the Mathematical Demonftrations of the Aftronomers, as well as by fo many Places of the Holy Scriptures; fuch as $P \int$. lxxiv. v. 16. Thou haff prepared the Light and the Sun; and Pf.cxxxvi. v. 7. To bim that made great Lights ; and many others, have feen that the Spirit of God himfelf has appointed this great and glorious Body for a certain Proof of the Infinite Power of the Maker and Ruler thereof ; and yet they hardly feem to have formed a right Notion of it. Befides Cuftom, the Weaknefs of our Imaginations feems to be the
principal Caufe thereof, which is unable, as well by reafon of the Smallnefs of many Creatures that we are forced to view with Microfcopes, as becaufe of the Greatnefs of thefe heavenly Bodies, to reprefent them properly to us: And tho' no Body that underftands Demonftration can doubt thereof, yet every one will find how defective his Imagination is in forming juft Ideas of their real Greatnefs or Smallnefs: Of this we have no occafion to produce any Proofs; let every Man only examine himfelf, and fee whether he does not difcover within him, what many of the greateft Mathematicians are obliged, with Shame, to confefs, that they themfelves experience concerning this Matter: See what Mr. Huygens fays about it in his Cofmotheoros, p. 124, and 125, who, to obviate this Weaknefs of the Humane Imagination, endeavours to make ufe of another Means, to imprefs more ftrongly upon our Minds the Greatnefs of the Works of our adoreable Creator, and of the Diftance of the Sun from the Earth; fhewing, that if we fuppofe with him, that the faid Diftance amounts to 12000 Diameters of the Earth (which yet is much lefs than what the Modern and moft Accurate Aftronomers do with good Reafon maintain) that a Bullet fhot out of a great Cannon, and moving in an equal Degree of Velocity, will be 25 , or at leaft 24 Years in paffing from the Earth to the Sun.

SEC T. XVII. How much Time is required for a Cannoin Bullet to pafs from the Earth to the Sun.
Now that what has been advanced by Mr. Huygens does not exceed the Truth, will appear :
I. Becaufe, according to the moft exact Menfuration by the French Mathematicians, a Degree of a Great Circle upon the Globe of the Earth

Earth amounts to 5.7060 Toijes or Fathoms of fix Foot; from whence it follows, that the Diameter thereof amounts to $6.538,594$ of the like Fathoms, according to the faid Mr. Huygens and Whifon in his Pralect. Aftron. p. 13.
II. This being multiplied by $\mathbf{1 2 0 0 0}$, the $\mathrm{Di}-$ ftance of the Sun from the Earth, amounts to 78,463,128,000 of French Fathoms.
III. Now by the Experiments of Merfennus, a Cannon-Bullet advances in a Pulfe, or the Second of a Minute, about a hundred of the aforefaid Fa thoms, it therefore requires $784,631,280$ Seconds to pafs with the like Swiftnefs from the Earth to the Sun.
IV. This Number is fomewhat fmaller than $788,940,000$ which are the Sum of the Seconds of Twenty five Years, if one allows to each of 'em 365 Days and 6 Hours, as may appear by the Calculations of the faid Mr. Huygens.

Sect. XVIII. How much Time is required for a Ship, or any Living Creature that can run Fifty Miles in a Day and a Night, to pafs from the Earth to the Sun, and Convictions from thence.

Now if the Swiftnefs of a Cannon-Bullet fhould too much dazzle any ones Imagination; let him fuppofe a nimble Animal, fuch as a Horfe, a Deer, a Bird, as alfo a Ship, either of which, if they can advance Fifty Miles every Twenty four Hours, will at leaft require 1100 Years, either to run, fly, or fail, fuch a Space, as is between the Sun and the Earth, which may be eafily computed, if one again fuppofes:
I. That the Sun is diftant from the Earth 12000 Diameters thereof.
II. That a Degree, according to a Pilot's Calculation, being fifteen Dutch Leagues, the Circumference

## The Religious Pbilofopber.. $\quad 765$

ference of the Earth will amount to 5400, and its Diameter to 1718 Dutch Leagues.
III. This being multiply'd with 12000 , the Product of Dutch Leagues between the Sun and Earth, will be $21,616,000$.
IV. This being divided by 50 , or the Miles that a Ship will fail in a Day, or a Horfe run, the Amount will be 412,320 Days, or about 1129 Years.
I thought I could not do amifs in being fomething the more large upon this Subject, and in fhewing the Sun's Diftance from the Earth after more than one manner; fince Mankind are wont, upon this Occafion, to reprefent to themfelves a Giant like a Dwarf; and the great Firmament, and thole glorious Bodies which it contains, and efpecially the Sun, with refpect to its Magnitude and Diftance, incomparably fmaller than they really are, and confequently make the dreadful Power of the Creator, Contemptible inftead of Wonderful and Infinite.

## Sect. XIX. The Swiftnefs of LIGHT.

Let the Atheif now go on with us, and Contemplate that Wonder of all Wonders, that furprizing Creature the Light, in its Properties only, fo far as they are known to us, and in the firft Place, its unconceivable, and (if it had not been proved experimentally, its altogether) incredible Velocity.

It may perhaps appear ftrange to many, and even not to be admitted by moft, if we fhould affirm that Light requires fome Time for the Parts of it to defcend fuccefively from the Sur to us, and in that manner to be emitted from all Parts of that Glorious Body : Forarmuch as the
chief Philofophers of the laft Age, and many others of this, to whom the lateft Obfervations of the Aftronomers are not yet known, have thought, and with great Appearance of Truth too, that Light moved much after the fame manner as a Stick lying between the Sun and us, whereof one End being protruded from the Sun, the other in an inftant, and without any Space of Time, would be likewife moved; fo that properly and according to this Hypothefis, the Light does not come down to us from the Sun, but that which is near and about us is only put into a continual Motion by the Sun, or by the Power of its heavenly Matter. But they that are of this Opinion, will be yet much more fhock'd, if we fhould tell them, that this Light is not only derived to us continually from the Sun, and that it requires fome Time to pafs to us, but even that it is protruded with fo great a Swiftnefs, that it does not take up more than half a Quarter of an Hour, or about $7^{\frac{1}{2}}$ Minutes to pals from the Sun to us, that is to fay, to run fo many Millions of Miles.

Sect. XX. An Experiment to prove that Light really moves and comes from the Sun.
$A_{n}$ actual Proof that Light moves, and that even when the Rays of it are collected in any Quantity, it will protrude Bodies it meets in its Courfe, and, as it were, blow them away, may be found in the Hiftory of the Royal Academy of Sciences, 1708, p. 25. where Mr. Homberg relates, That a Light Matter, fuch as the Amianthus, or Plume-Allum, being fuddenly brought into the Focus of a Burning-Glafs, upon a Wood-Coal, was driven off by the concurring Rays of Light; and that the Spring of a Watch, one End of which faften'd faften'd in a Piece of Wood, being likewife placed in the Focus of a Glafs of twelve or thirteen Inches, the Rays ftruck againft the loole End of it, and caufed it to move backwards and forwards juft as if it had been thruft with a Stick:

Now this does undeniably prove a great Swiftnefs of Light ; yet this amazing Courfe of it, as it furpaffes all Imagination, fo with many would it exceed all Appearance of Truth, were it not that the ten Years Obfervations made by Mr . Romer, upon the Eclipfes of $\mathcal{F u p i t e r ' s}$ Satellites, had put this Matter fo much out of Difpute and Doubt, that the greateft and moft accurate Mathematicians have been forced to admit it upon the Strength of thofe Experiments.

It fhall fuffice here, that we may not fwell this Difcourfe too much, to produce only the Teftimony of Sir IJaac Newton, tho ${ }^{5}$ we could likewife add many others; thefe are the Words of that Gentleman in his Princ. Pbilof. p. is 1. Propi. 96. Lib. I. in the Scholium. For that Light is pufbed on fucceffively, the Parts of it following each other, and that it pafles from the Sun to the Earth in the Space of ten Minutes (in the fecond Edition he has alter'd it to Seven or eight Minutes) is now certain by the Appearances of Jupiter's Satellites, and confurmed by the ObServations of feveral Aftronomers.

And when afterwards he publifhed his Oprick $\dot{s}_{9}^{7}$. which are proved and illuftrated by a Number of wonderful Experiments, we find him fpeaking after this Manner, in the Eleventh Propofition of the Second Book of the Third Part, p. 236. The Light is tranfmitted in ä certain Space of Time from thë illuminating Body, and employs about Seven or eight Minutes in its Courfe from the Sun to the Earth: Where-upon he adds the Proof, the firft Words of which are, This was firft obferved by Romer, and after= guards by others, by Means of the Eclipfes of Jupiter's

[^1]Satellites: In his fecond Edition of his Opticks $\xi_{j}$ he only allows about feven Minutes for this Paffage of the Light.

They that defire to fee this more largely proved, may confult Mr. Huygens, in his Treatije of Light ; Mr. Whifton in his Pralect. Afronom. and others. Befides, that the Impoffibility of the contrary Hypothefis has been already fhewn both by Newton and Huygens.

It is fufficient for us, fince we cannot here defcribe the Particularities of Aftronomy, to fhew that this has been proved to be an unconteftable and certain Argument, by the moft accurate Inquirers into the Nature of Light, and that the boldeft Atheifts have no Reafon to doubt thereof, unlefs they underftand nothing of Mathematicks, or are ignorant of the lateft Difcoveries about the Properties of Light; or if they would be pleafed to read the aforemention'd Aftronomical Lectures of Mr. Whiffon, P. 229, and 230 . where the Recti-linear Progreffive Motions of the little Particles of the Light are largely handled and proved beyond all doubt; and where he fhews, according to the niceft Obfervations, that in half a quarter of an Hour's time, the Light paffes through all that Space that is between the Sun and the Earth. And this being allowed, let them refiedt with themfelves, whether it be credible, that it is by meer Chance, and without any Direetion, that Bodies protruded with fuch an amazing Swiftnefs, can always obey fo many Laws without once varying in their unconceivable Progrefs, as it has been obfrervea with refpect to Light upon fo many Occafions; of which more hereafter.

Sect. XXI. What would be the Confequence, if the the Rays of Light foould become a Solid Body, and the Parts thereof adhere to each other.

I Shall here add, that I have been exceedingly affected with the Confideration of the dread ful Velocity of Light, as often as I thought that if once fo many Particles thereof fhould adhere to each other, fo as to compofe a little Body, weighing no more than the tenth Part of a Grain, they would exert as great a Force by the Swiftnefs of their Motion in ftriking upon any Body upon the Earth, as a Bullet of twelve Pound Weight fhot out of a great Cannon.

Now that it is not impoffible that Light frould become a folid Body, feems to be proved by that Matrer which we at prefent call a Pbofphorus; which feems to confift altogether, or for the moft part, of a combined Fire or Light ; forafmuch as if we put the fame into Oyl of Cloves; the Light thereof cleaves to the Oyl , and caufes it to fline, as is known to the Chymifts.

And now that no body may think fuch a dreadful Force improbable, which we fuppofe to be in the defcending Light; in the aforefaid $\mathrm{Cir}^{-}$ cumftances, let him fuppofe :
I. That Light paffes in half a Quarter of ari Hour, or 450 Seconds from the Sun to the Earth; which has been fhewn above to amount to the Number of $78,463,128,000$ French Fathoms.
II. It follows then, that this beins divided by 450, the Light paffes thro ${ }^{3} 174,362,506$ thereof in one Second or Pulfe. Let us fuppofe it, for, the fake of a round Number, to be juft $174,362,500$.
III. Now a Twelve-pounder fhot out of a Can non is found to advance in the fane time a hunz dred of thefe Fathoms:

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IV. And chanicks and the Doetrine of Percuffion, that the Force of Projectiles, with refpect to their Courfe and Percufion, are in the fame Proportion to each other, as their Weights multiplied with the length of the Way which they make in the fame Time.

Now for the fake of thofe that do not underftand Mathematicks, we fhall fpeak a little more plain, and fay ; that a Bullet of fix Pound, which in a certain Time runs the Diftance of 200 Fathom, has twice as much Force, as a Bullet of twelve Pound, that runs but 50 Fathoms in the fame Time; for 6 times 200 makes 1200, and 12 times 50 is but 600 , or the half of 1200: After the fame manner, a Bullet of 12 Pound running 100 Fathom, in a certain Time, has as much Force as a Bullet of 6 Pound that runs 200 Fathoms; of 3 Pounds and 400 Fathoms; of 2 Pounds and 600 Fathoms, in the fame Time, , $c$. forafmuch as the Weight of each of thefe Bullets being multiplied with the Way that they make in the fame Space of Time, does always produce the like Number of 1200 .
V. From whence we may infer, That in cafe an Aggregate of Light by its Velocity, does act with the fame Force as a Bullet of 12 Pounds; then in order to find out theWeight of the Light neceffary thereto, this Rule will have Place.

Wherefore, as the Length of the Way (or as 174,362,500 French Fathoms) which the Light goes in the Second of a Minute, is to the Length of the Way that fuch a Bullet runs in the fame time (or to 100 of fuch Fathoms;) fo is the 12 Pound-weight of the Bullet to the Pounds, or rather to theWeight of this Body of Light, that has the fame Force.
VI. This Rule of Three being calculated, the Weight which the Light will have upon this Ocfion will be ${ }_{27}^{745025}$ of a Pound.

And fuppofing a Pound, of 16 Ounces, to contain 7680 Grains, and thofe Ounces to be Troy-Weight, the Weight of this Body of Light will be $\frac{92160}{x 743625}$, or about $\frac{1}{\frac{1}{8}}$ of a Grain, as is faid before.

## Sect. XXII. Conviđtions from thence.

Now in order to be convinced not only of the Prefence, but likewife of the Neceffity of a Divine Direction, fince this dreadful Swiftnefs of Light is known, and fince we find by Experience, in thoufands of Bodies, that Light will adhere to them, and become a folid Body, and they being kindled, it will appear again; let an unhappy Infidel once more ask himfelf, by what Law or Neceffity of Nature it happens, that this Light never comes to be turned into a little folid Body, whilft it is in the Sun, and fo defcend to us with its ufual Celerity; whereas Water is converted to Hail in the Air, and the Spots in the Sun feem to reprefent fuch a Cohefion of Parts. Certainly if Chance only had place here, we cannot give the leaft Reafon why it fhould not fo happen, or why a dreadful Storm of thefe collected and compreffed Particles of Light, fhould not overfpread the whole Earth with utter Deftruction in an Inftant.

## $\mathrm{Sect}^{\mathrm{E}}$. XXIII. Light runs in frait Lines:

One of the Properties of Light is, its Mo tion in Right Lines, from whence, according to all Experiments, the Separation between Light and Darknefs is juftly deduced, and fo likewife are the Shadows in PerfpeEtive.

To give an Inftance thereof: It is known that the Rays (Tab. XX. Fig. 3.) proceeding from the Points of the Sun, A and B , and thofe that lie between, if they run directly forwards according to the Lines AP and B P; do form the Cone of Shadow or Pyramid, C D P; whereas on the contrary, if the Light did not move in ftrait Lines, but in all kind of Curves, as Sounds are propagated, there would be no Darknefs or Shadow where the Light could have no Accefs, and confequently no Separation between Light and Darknefs.
> $\mathrm{S}_{\ddagger} \not \subset \mathrm{r}$. XXIV. Experiments to prove that Fire is produced by Light.

Another Property of Light is, that it is either Fire it felf, or that it carries a great deal of Fire with it ; and they that have a Mind to be furprifed with the Powers and irrefiftable Motions that do appear in this Fire, and by which it is difpofed (when united in any confiderable Quantity) to confume every thing in the moft dreadful Manner; let them take an occafion to view the Force of the new-invented Burning-Glaffes of Meffieurs Hartfoeker and Tfchirnbaus, or to read the Effects thereof. Lead and Pewter of a confiderable Thicknefs are immediately melted by the faid Burning-Glaffes; wet Wood will burn in an inftant ; Brafs and Copper, and even Iron Plates, wvill glow and melt prefently ; and many People know how much Time is requifite to caufe hammer'd Iron to flow in the hotteft melting Furnaces. Bricks, Pumice-fitones, and Earthen Vef? fels even full of Water will be diffolved and vitrified, and the Water at the fame time almoft boyled, Asbefus, Plume-allum, (which, according to the Teftimony of Kircher, will even bear the Fire of
the Glafs-Blowers without any Alteration) as alfo Gold, upon which all the Powers of our common Fire have been in vain employed hitherto, (and of which mention is made above) are turned to Glafs in the Focus thereof. They who defire to fee a more particular Account of thefe Matters, may confult the AEZ. Lipf. 1687. p. 52. 1688. p. 206. 1691. p. 518. and the Hiftory of the French Academy of Sciences.

## Sect. XXV. Convittions from bence.

Now let an Atheift who knows from all this, that the Rays of the Sun do either confift of fo devouring a Fire, or do carry a great Quantity thereof along with them ; or, if he has ever obferved the terrible Force thereof in its Effects; I fay, let fuch a Man firft reprefent to himfelf the almoft incredible Velocity with which it comes down to us, and compare therewith the Force protruded by a little Flame of a Lamp, with which thofe that blow Glafs do make it glow and melt when they blow againft it with any kind of Swiftnefs; and then let him tell us, whether he can think, without Uneafinefs, that this great Solar Body tranfmits Fire to us with fo terrible a Velocity, and that it is only owing to meer Chance that there does not come down a greater Quantity of this dreadful burning Matter, and overturn and deftroy the whole Globe of the Earth with an unextinguifhable Flame. And if he imagines, that this Earth is fecured by fixed and neceffary Laws of Nature from being confumed with Fire, how can he prove that fince one Day is fair, and there is fcarce a Cloud to be feen in the Sky, but the next is continus ally rainy and ftormy; may there not likewife fuch an Alteration happen in the Sunto motrow, whereby

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cvery is nothing more required to keep fuch an Infidel in a continual Fear (if he be true to his own Principles) as the Confideration of that Danger with which he is threaten'd every Moment, if the Light of the Sun were moved by meer Chance only, and without a Wife and Merciful Direction.

## Sect. XXVI. The Quantity of Light.

Now let a Philfopher, who feeks for his unknown God in the true Difpofition and Structure of the Things of this vifible World, contemplate with us the amazing, and fcarce conceivable Quantity of this Light, which is continually and inceffantly tranfmitted from the Sun. We have faid fomething upon this Subject before, when we treated of the Fire in the Air, and fo far as it related to Light; but in order to be yet more fully convinced thereof, it is certain, by Experience, that this Light fills our whole Air, and all that Space that is between us and the Sun, at leaft; that, excepting the Shadows, there is, no Place, tho' never fo fmall, where it does not fhew itfelf; [We exprefs our felves thus that, no Body may except againft the Word fill.] We can perceive it in the two loweft Planets Mercury and Venus; in the Moon which moves about the Earth ; and even in the three uppermof Planets, Mars, Jupiter, and Saturn: From whence it is farther apparent, that this Light does fufficiently fill all thofe Places to which it extends itfelf, fince wherever the Eye, or the Sun alfo, and thofe other heavenly Bodies may be placed, either the Sun itfelf, or its Light, which falls firt upon the Planets, and is from thence reflected to us, may be feen, unlefs fome intervening dark Bodies prevent the fame.

Now if any one would examine how great that almoft inconceivable Space is, which is continually filled with the Light proceeding from the Sun, (to fay nothing here of the fixed Stars) let 'em fuppofe with the modern Aftronomers according to the Table by which Mr. Huygens made his Automaton, p. 447. that the Diftance of the Earth from the Sun with refpect to that of Sa turn likewife from the Sun, is as 100 to 951 ; that is to fay, Saturn is about 9 , $\frac{x}{2}$ times farther from the Sun than the Earth. Now 'tis plain enough, according to the modern Experiments, that the Diftance besween the Earth and the Sun amountsto about 12000 whole, or 24000 Semidiameters of the Earth, and therefore that the Diftance of Saturn being $9^{\frac{5}{2}}$ times as great, it amounts to 228,000 Semidiameters of the Earth : For which Reafon a Globe that would fill theSpace betweenSaturn and the Sun, would contain II $852,352,000,000,000$ Globes of the Earth; thefe Globes being to one another as the Cubes of their Semidiameters: So that now every body that confiders this almoft inexpreffible Number of Globes equal to that of the Earth, that are requifite to compofe one only equal to the Orb of Saturn, will eafily agree, that the Space which is filled with the Light of the Sun, may be juftly termed, in a manner, unconceivable.

But if we go farther, and in order to demonftrate the Quantity of Light, confider together with this Vaftnefs of Space, the Swiftnefs of the Light, which, as we have fhewn before, paffes from the Sun to us in $7^{\frac{1}{2}}$ Minutes, or about the eighth Part of an Hour, it will appear thereby, that it paffes from the Sun to Saturn, or to the nitmoft Part of the Orb (being defcribed upon its Diftance from the Sun as a Semidiameter) in $9 \frac{5}{2}$ times fo many Minutes, that is to fay, in ${ }^{\frac{1}{2} \frac{3}{8} \text { Hour ; at leaft, if it be fuppofed that Light }}$ locity ; for which reafon this great Orb will be emptied again in lefs than five quarters of an Hour, if the Light paffes thus fwiftly on; and therefore there muft proceed fucb an unfpeakable quantity of Light from the Sun, as fhall fuffice in 24 Hours to fill fo great an Orb about twenty times.

## Secr. XXVII. Convitions from thence.

Now I leave it to an Atheift (who would not dare to maintain it the prefence of wife Men, that his Candle which ferved to light his Chamber in the Evening, came there by chance) to judge himfelf, whether this glorious Sun, this wonderful Fountain, from whence for fo many thoufands of Years there daily flows fuch an unconceivable quantity of Light, can be believed by him to be produced without Wifdom; and wherher all the Benefits which it continually occafions to thofe that inhabit the Earth, cannot demonftrate to him that a great Power (which ought juftly to be dreaded by his Enemies) together with the Will as great to do Good to Mankind, had place in the Production of the Sun : And whether fo prodigious a Body, with continual Streams of Light flowing from it, and which by its dreadful Velocity feems capable to hurry all things away with it, has been able to ferve for warming and enlightning Mankind, and by fertilizing the Earth to preferve them alive, without a wife Diretion and Government, for fo many Ages?

Let it not be objected here, that the Sun by conftantly illuminating a Sphere as big as the Orb of Saturn, or bigger (fince it is credible, that the Lighṭ of thẹ Sunn diffefues itfelf beyond Saturn) and filling
filling it fo often with Light, and by having lafted as many Years as the World, may feem to have almolt confumed all its Light; and fo if not quite wafted, yet muft be greatly diminifhed, fince that is contrary to Experience : For in Anfwer thereto, befides, that no Body can be perfectly aflured, that Light does not circulate like the Blood in Animals, and after having performed its Courfe, comes back to the Sun again.; which Cartefius, probably to avoid this Objection, feems to have thought: I fay befides this, the Particles of Light may alfo be conceived to be fo very fmall, that notwithftanding they do fo far fill this whole Orb, that the Interfices or Spaces that are between, may remain entirely unobferved by us; yet being taken all together, they may not perhaps amount to the quantity of one Grain of Sand; for which Reafon there could be no Diminution perceived in the Body of the Sun in as many more Years or Ages.

Now as wonderful, and perhaps as incredible too as this may appear to many, it is neverthelefs well known to the Mathematicians, that the great Space of which the Starry Heavens fhou'd be fuppofed the upper Superficies, might be filled in fuch manner with corporeal Particles, that no one Ray of Light, how fine and flender foever, if it had but a determinate Magnitude, could be able to pafs between the fame, and confequently the faid great Space would be abfolutely opaque. All which corporeal Particles, if they were joyned together, would neverthelefs not only not make the quantity of one little Grain of Sand, but even not of the fmalleft Part thereof, provided its Magnitude were likewife determinate. See Dr. Keil's Introduction, p. $54,8=55$.
SEc.
$\mathrm{S}_{\mathrm{EC}}$. XXVIII. The Ufefulness of the Divergency of Light.

But if an Atheift fhould confider this continual and fwift Stream (as it really is) proceeding from the Sun, not only as it brings Light always with it, but likewife an actual Fire; he muft be forced to confefs, according to the Experiments of the Burning-Glaffes, that if this Light and Fire fhould defcend to us in fuch a clofe and compreffed Body as we find it is when the Rays of it are collected in the Focus of the faid Glaffes, the whole Globe of the Earth with every thing belonging to it, would foon be reduced to a more dreadful Glowing than Metals put into Fufion in a Furnace. Now it is fure enough, that this fiery Light is more hot and deftructive near the Sun, than in the aforefaid Focus; fo that in order to convert the Earth into a glowing Ocean, of which one can hardly think without trembling; nothing more is required, than that the Light fhould come down quite to us with its Rays, as compact and clofely united to each other, as it really is near the Sun.

This being laid down, let him feriounly weigh. with himfelf, whether he can think it to come to pals without Wifdom and Direction, that there is fuch a Motion communicated to the Rays of Light, and fuch a Law prefcribed to them, which they have ftrictly obeyed hitherto for fo many Ages, without once receding from ' em , tho' they themfelves are entirely ignorant thereof, and whereby the Earth, and even the Univerfe itfelf have ftill been preferved from this allconfuming Fire. The Laws we mentioned to which Light is fubject, are, that as foon as it comes from the Sun, the Rays of it are featter'd

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 more and more fo, the farther they proceed in Right Lines. This the Learned exprefs by the term of the Divergency of the Rays.Of this we have fpoken before, when we treated of the bufinefs of Vifion, or Sight, and of Fire; and to avoid Repetitions, we fhould have paffed it by here, were it not that from this Divergency or Separation of the Rays of Light, there feem'd to refult a Proof, which is alone fufficient to caufe an Infidel to fee with indifputable Clearnefs, that there is a God that governs this now fo beneficial and ufeful, but otherwife fo terrible, Subftance of Light and Fire, and thereby preferves from unavoidable Deftruction, every thing that has Life and Being upon the Earth.

Sect. XXIX. The Properties of the Divergency of Light.

We fhall only add the following, to what has been faid before upon the fame Subject, to the end that thofe who are not verfed in Opticks and other parts of Mathematicks relating to Light, may have plainer Notions thereof: Let it be then fuppofed (Tab. XXI. Fig. 2.) that $S$ is a Point in the Sun, from whence the Rays $S a A$, $\mathrm{S}_{c} \mathrm{E}, \mathrm{S} c \mathrm{C}, \mathrm{S} d \mathrm{D}, \mathrm{S} b \mathrm{~B}$, $\overbrace{c} c$. in their Progrefs from $S$ to $A, C, D, E$, continually diverge or recede as they move from each other: Now there need not be much pains taken to fhew, that the fame Rays which at the diftance S B, fall upon the Plane Circle A E CD, when they are nearer to the Sun; and for Inftance, when they have proceeded no farther from it than to $S b$, are all within the Circumference of a fmaller Circle $a e c d$; and confequently, that the Fire of which thefe Rays confin, or at leaft which preffed together in the little Circle aecd, than in the great one A ECD, as this laft is bigger than the former ; or to fpeak in the Language of the Mathematicians, the Heat which the little Circle aecd undergoes, is fo much greater than that which the bigger Circle A E C D feels from the fame Rays, as the Square of the Diftance of the great Circle; or of S B or SA, © $\sigma$. is greater than the Square of the Diftance of the little Circle, or of S $b$ or $\mathrm{S} a$ : That is to fay, when S B is twice as great as $S b$, the Heat at $a e c d$ is twice two times, or four times greater than at AECD; and fo SB being 100, and S 65 ; their Squares are 100 times 100 , and five times 5 , or 10,000 and 25 ; and confequently the Heat at aecd: Is to the Heat at A ECD: As 10,000: To 25, or as 400 to 1, which is likewife confirmed by Experience.

From whence it is then manifeft, that if one knows how much one Place is nearer to the Sun than another, one may likewife according to this Rule, make an exact Calculation how much more Heat is produced by the Rays of the Sun at one Place than at another upon occafion of their Diftance; and generally that 'tis true, that by how much the nearer any thing is to the Suns $_{3}$ fo much the greater Hear it muft undergo from the united and compacted Rays thereof; as alfo the farther it is from the Sun, the lefs will it feel of its Heat.

Now as this is known to be true by all Mathematicians, let an unhappy Atheift confider in his Retirement, whether he thinks it can be by Chance, that a glowing Sea of Fire above 100,000 times bigger than the whole Globe of the Earth, is about the Sun at S , the burning Rays whereof SB, SA, SE, SC, SD, © c. comie deviry

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down with fo unfpeakable a Swifnefs inceffantly; (and therefore in fuch a Number as is hardly to be conceived) upon the Earth at ADCE; and yet that this terrible Fire does not immediately, and in the moft difmal manner confume every thing upon it.
'Tis true indeed, that the Diftance S B, which is between the Earth B and the Sun S, being of the Length of iz,000 Diameters of the Earth, may contribute fomething thereto ; but yet this beautiful Globe is by no means preferved from the aforefaid terrible Deftruction by this only. To underftand which, let it be fuppofed, that there comes down from the Point of the Sun $S$ upon the Earth, the Rays $\mathrm{S}_{a}, \mathrm{~S}_{e}, \mathrm{~S} b, \mathrm{~S}_{c}, \mathrm{~S} d, \mathcal{\sigma}_{c}$. without Diverging, or in parallel Lines, and clofely joyned together; or (to render the Notion thereof yet clearer) that the faid Rays being near the Sun at the Point $B$, are diverged and feparated from each other as they go, but proceeding farther lofe their Divergency; and defcending down by their Parallelifm or Equidifance form the circular Column $a c m k$, it is plain, that all of ' em will fall upon the Circle $k m$, and there produce a Hear, which is fo much greater than that which would be perceived in the great Circle AECD from the fame diverging Rays, as this laft Circle is bigger than the little one $k$ 'm. This appears from the Burning-Glaffes, the Force of which does only confift herein, that the Rays are collected into a fmaller Compafs; fo that they give a clear proof of this Truth, that the Rays of the Sun being collected into a narrower Compafs, even at fo great a Diftance from the Sun itfelf as is the Earth, are yet capable of producing a terrible Heat. From whence then it does follow certainly enough, that it is not fo much the Diftance of the Sun, but the Diver-

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gency or Scattering of its Rays more and more, which chiefly diminifh the force of Burning; and that the faid Diftance or Remotenefs does hardly contribute more towards preferving the Earth from an entire Conflagration, than by the diffipating and feparating the Rays more and more from each other, in proportion to the Length which they run.
$S_{\mathrm{E}} \mathrm{C}$ r. XXX. Two great Ufes of the Said Divergency.
From this Divergency of the Rays of Light from all Points whatfoever (which mult be confidered as a Wonder by all Men) we may deduce thefe two.Advantages, which the adorable Creator beftows upon us, and which we have before already hinted :

Firf, That the Earth is thereby fecured from being confumed by the Sun.

Secondly, That by fuch Divergency all Bodies are enlighten'd on all Sides by the Rays that are fcatter'd upon 'em, and thereby render'd vifible to every one. Thus we find in Vol. I. Tab. X. Fig. r. that the Rays of Light K P falling from the Candle K upon a Point P (for Inftance upon the Point of a Needle) feparate themfelves from one another there, as well as at the Candle itfelf, and fo render the faid Point vifible in every Part.

## Sect. XXXI. Refractions and their Ufes.

Bu r forafmuch as (Tab. X. Fig. 3.) thefe Rays from A, diverging and filling the Space AS T, the fame would alfo happen from all the other Points N, L, M, B, \&rc. of the Object AB, and therefore the fame Rays diverging, for inftance, from $B$ and $A$, will be entirely mingled with each other at $S O T$, and fo reprefent to the Eye at S T a confufed Light of all the furrounding Objects, but no diftinct View of any one; there feemed therefore fomething to be fill deficient to render the Light compleatly ufeful to us; and that befides the rectilinear and divergent Motions of Light, there was yet another Law requifite, by which all the Rays proceeding from A or B might be again inflected towards each other, and gather'd together in fo many particular Points $a$ and $b$, which has been already proved to be the fole Caufe of diltinct Vifion.

Befides this, to the end that the Light may be as ufeful to us as poffible, fince the Sun when it Sets would turn the perfect Day in a very fmall fpace of Time into thick Darknefs, and when it Rifes, would change a Night as dark as Pitch in a few Minutes into a bright Day ; by which means our Eyes paffing fo fuddenly from one Extream to the other, might be much prejudiced and weaken'd, as Experience often fhews; there feemed to be a Means neceffary to caufe the Brightnefs of the ftrong Light of the Sun to advance and recede gradually; and this is brought about by the Morning and Evening Twilights.

Now I wou'd ask an Atheift, who pretends not yet to be able to difcover the wife Purpofes of him that has prefcribed fuch Laws to the Light; and which it ftrictly obeys, Whether he could have found out a better way to avoid the abovemention'd Inconveniences, than by enduring Light with the Properties of Refraction, whereby, as we have already fhewn, the two aforefaid Difficulties may be obviated? And fince they are actually prevented by this Method; what Reafon has fo unhappy a Philofopher to deny the Wifdom of the Creator and Ruler of fo glorious a Body ?

## $\mathrm{S}_{\mathrm{E}} \mathrm{C}$. XXXII. The Reafon of the Angles:

Now to fhew that thefe Refractions of the Rays of Light can't be afcribed to mere Chance, let, (Tab. XXI. Fig. 3.) a Ray S O proceed from the Sun $S$ to the Superficies of the Water F G; and fuppofe from the Center O a Circle FB G.P defcribed as large as you will, it is experimentally true, that the Ray BO does not proceed ftrait forwards to R, but at O makes the Angle BOP, for which Reafon the fame Ray being thereby, refracted proceeds from $O$ to $P$, according to P O, which is termed the refracted Ray.

After the fame manner the Ray $b \mathbf{O}$, does not proceed ftrait forwards to $r$, but breaks at $\mathrm{O} p$ : Now whether thefe refracted Rays O P and pO do likewife run in ftrait Lines, or elfe as often as they meet with frefh Refiftance or Reverberations are again inflected, we don't here difpute.

Now I leave any one, that is reafonable, to judge whether he imagines it poffible to happen without any Direction, that all the Rays O S, Os , and all others that with different Ob liquity fall upon the Water F $G$, as here at $O$, with fo dreadful a Velocity, with which they are protruded; and that being entirely ignorant of all, things elfe as well as of themfelves, they can obferve fuch a Law without once departing from it, that their broken Rays, OP, O $p$, do exactly ever take the fame Way; that (fuppofing the Lines A B, $D P, a b, d p$ to beall at Right Anglesto $a d$, which is likewife at right Angles with Refpeci to F G) the faid A B and PD, as alfo ab and $p d$, will always have the fame Ratio to each other; fo that to fpeak more plainly, as $A B$ is two or three times as long as $P \mathrm{D}$, in all the other Incident

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Rays, as here at $b 0, a . b$ will be twice or thrice as long as $p d$; nor will there be, in fo many Millions of Rays that fall in fuch various Obliquities upon F G, and penetrate into the Water, one fingle Ray to be found, notwithftanding their furprizing Swiftnefs, that don't perfectly follow this Rule, at leaft if all the Rays are of the fame Kind.

Sect. XXXIII. The Structure of the Eyes with ree: Spect to Light.

And as when we treated of the Eye, we mention'd the Properties of Light as an unconteftable Proof of the Wifdom of the Creator; fo whilft we are here fpeaking of Light, we fhall briefly apply the Structure of the Eye, fo far as it relates to Light, to the fame Purpofe; and the moft obdurate Atheift, unlefs he abfolutely refufes to liften to any convincing Proofs, is intreated by us, that he would again attend to what we have faid in the Contemplation about Vifion.

Sect. XXXIV. The Power of Bodies to reflect Light.

Bu t now tho' Light fhould fall upon the Eye; and tho' the Eye were furnifhed with all the aforefaid Qualities for receiving the fame; yet that whole Difpofition, and all thofe Properties would be in vain, and the noble Globe of the Earth would be of no more Advantage to the Inhabitants than it is to any Body now who is ftark blind; unlefs befides all this, the Bodies upon which Light falls had the Faculty of caufing the fame to rebound back from them, and to reflect: the Rays thereof to all Places round about :em.

Now fince this Property occurs in almoft all vilible Objects, will an Atheift fay, that this was likewife by Chance, nor that the great End thereof was, to render Bodies vifible?

And if it fhould appear to him too abfurd to afcribe all this to meer Chance only; let him then tell us, what Neceffity there is in the Combination of Caufes, why almoft all Bodies do enjoy this reflecting Power, with refpect to Light; whereas there are many which in relation to others that ftrike upon or againft ' em , do not exert fuch a Power, nor drive them back again with any Repercuffion. Thus we fee, for inftance, That every thing which falls with any Degree of Swiftnefs upon foft Clay, remains fticking in it, and is not reflected; and yet the contrary happens when thofe exceeding fwift Particles of Light fall upon the fame; for how fmall foever they be, they rebound from it, and thereby render the Clay vifible. We might relate many more Wonders concerning this Matter, which we fhall pafs by here, having occafion to fay fomething of them hereafter.

## Sect. XXXV. The AIR Invifible.

Moreover, fince this Property of Reflecting Light, is in a manner common to all Bodies, excepting perhaps fuch as are black (which by many is fuppofed to be occafion'd hereby, namely that Bodies fo tinged do not reflect any of the Rays of Light that fall upon them, for which Reafon they have no other Idea of this Colour but as of meer Darknefs) Now muft we not herein again confefs a wife Difpofition of the Great and Gracious Creator, who, notwithftanding that he has made Water and many other fluid Matters vifible, yet feems to have excluded
excluded the Air only, for the moft part, from that Faculty, notwithftanding that that alfo in itfelf is vifible like other Bodies, and feems to be very well adapted thereto by its Elaftical and other Properties, as appears when we comprefs a great Quantity of Air in the Pump, and then fuddenly let it out again by the Cock? Now let an Atheift ask himfelf, whether this can appear to him to be fo order'd without any Defign or Purpofe ? And fince the Air itfelf being thus vifible, and fo far capable of ftopping the Courfe of Light, would caufe us to live as it were in a continual Fog, and hinder us from feeing conveniently moft of the Objects about us, whether he does not obferve, that this fame adorable Wifdom does here interpofe after a wonderful Manner for the Be nefit of Mankind ?

## SEct. XXXVI. The Wonders of Reflections.

And to the end that many miferable Philofophers, who think they undertand fo well the Laws of Reflections and Refractions, fhould not imagine that there are not more Wonders concealed in the fame, and that their Underftanding does perfectly extend itfelf thereto, let them give a fatisfactory Reafon of the Appearances mention'd by that accurate Philofopher Sir Iface Newton, in his Opticks, p. 238, and 346, laft Edition; and tell us what is the Caufe that the Light paffing from a Glafs, and falling with a certain Obliquity upon a Place from which the Air has been exhaufted, does not proceed on, but returns back again to the Glafs ; and that when the Rays fall from the Glafs upon the Air with an Oblique Angle of more than 40 or 41 Degrees, the fame are likewife entirely reflected; whereas if they fall with W leffer Obliquity, moft of 'em will pafs thro the

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Air, fo that the Light which paffing thro' the Air upon the Glafs, can make itfelf a way thro' the fame, and yet the Light that paffes from the Glafs to the Air in the fame Obliquity feems unable to make itfelf a Paffage in a fo much thimer Matter, whereby to purfue its Courfe.

They that have a mind to fee many wonderful Circumftances befides thefe, may confult the above-mention'd Places, and from the Experiments there related, may with Certainty enough infer, that we do not rightly underfand the Nature of Light, with refpect to its Reflections, whilft we only confider it as a Globe or Ball rebounding from any hard Matter.

At leaft it is evident hereby, that there are Laws in Nature to which the Light is fubjected, of which perhaps none of the Naturalifts, if they had not thus found them true by Experience, would ever have thought.

Sece. XXXVII. Experiments fowing that Light may become a Solid Body.

I Might have here forborn to have enquired into certain Queftions propofed by Sir Ifaac Nerwton, in his Opticks, p. 349. Quaff. XXX. where that Gentleman feems to incline to the Opinion, that Light, befides its being the moft active Matter in Nature, may likewife become the Subftance of palpable Things, and be converted into a folid Body; but fince Mr. Homberg has put this Affair out of doubt by feveral Experiments recited in the Memoirs of the Royal French Academy, 1705. p. 122, $\mathscr{C}_{c} c$. it feems not improper to dhew here likewife this Ufe of Light. And,

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Firft, That Light penetrates almoft all Bodies, even thofe that appear obfcure to the Eye, and paffies thro' the fame, as is fufficiently known to fuch as make ufe of good Microfcopes, fince almoft every Object that has been viewed therewith, provided they are but thin enough, do in fome manner become tranfparent.

The faid Sir Ifaac Newton tells us in his Opticks, p. 223. That he has obferved the fame in a dark Chamber, when any Matter reduced to a proper Thinnefs, was placed before the Hole through which the Light would otherwife have paffed; and he only excepts white metalick Bodies, which feem to reflect all the Light falling on them.
Secondly, If we fuppofe Flame to confift for the mof part of Light, we fee that it turns to a folid Body in the burning of Chalk, and efpecially in the making of Minium or Red-Lead from Lead-Afhes, which after having burnt and glow'd a great while, become more heary.
Mr. Homberg likewife relates, that if Quickfilver, being reduc'd to the utmoft Fluidity by Steel and Antimony, be put over a Fire in a Glafs, the parts of the Fire which penetrate it thro' the Glafs, and which may therefore be deemed a Light without any additional Mixture, will change it into a Powder heavier than the Quickfiiver was at firf, and be of fuch Proof againft Fire, that it will bear glowing at leaft 24 Hours without any Evaporation; and when driven with a very violent Fire, it may indeed evaporate into Smoak, but will however leave a little Parcel of iffelf behind, which being formed by this Light in the Quickfilver, will affume the Qualities of a folid and malleable Metal: This may be farther confirmed by the Experiments made on the like Occafion by Mr. Boyle, by which he fhews how fome Bodies, flate up on every Side in Glafs, b:come thro' the Pores of the faid Glafs; but this is proved yet more plainly, and beyond all Difpute, by the following Experiment of the faid Mr. Homberg in the above-mention'd Place, who having reduced four Ounces of Regulus Martis to Powder, placed it about the Diftance of $\frac{1}{2}$ Foot from the true Focus of the Burning-Glafs of the Duke of Orleans, ftirring it about from time to time with an Iron Spoon ; by the Heat of this Light there afcended a great Smoak from the faid Re gulus for the fpace of an Hour, and then it ceared : And tho' one might expect, that by the lofs of all thofe Particles which evaporated in Smoak, the Weight thereof would have been diminifhed ; yet on the contrary, he found that the Weight of it was increafed $1 \frac{1}{2}$ quarter of an Ounce, and fome Grains, that is to fay, about a tenth part of the whole.

Afterwards he placed the fame in a greater Heat, or in the real Focus, which put the Regulus into Fufion, and then it weighed no more than $3^{\frac{\pi}{2}}$ Ounces; fo that he reckons that this lofs of the half Ounce happening by the Evaporation and Smoaking, one may fafely affirm, that the Light had firt augmented it with almof the Weight of a whole Ounce, which by melting, and the Operation of fuch great Heat was diffipated again.

Now whether this laft Calculation be juft or not, it plainly follows from hence, that this Regulus had in the firft of thofe Experiments gained by the Rays of Light, the Weight of almoft half an Ounce over and above all that evaporated in Smoak; which clearly fhews, that Light can conjoyn it felf to folid and palpable Bodies, and increafe the Matter thereof.

But the Reader is defired to confider this as
the firft Sketch of a new Difcovery: And I fhall not endeavour any farther here to determine, whether we ought with thofe great Mén abovemention'd, to confider Light as the chiefeft. and moft active Principle in Nature. This however feems to be unconteftably true, that Light is either a pure and uncompounded Fire, or carries fuch a Matter along with it; and how much ought to be afcribed to the Activity of Fire is fufficiently known to every one. Experience likewife teacheth us, how much all Plants and Animals depend upon the Influence of the Light of the Sun ; infomuch, that if it cannot be faid to be the only active Principle in Nature, at leaft it may be certainly reckon'd among the chiefeft.

Sect. XXXVIII. Optical Experiments pafled over.
I $S_{\text {hale not }}$ amufe my felf here to rehearfe the common and known Experiments about Light, which the Science of Opticks fuggefts as fo many Wonders, tho' they furnifh us with one of the greateft Proofs to demonftrate, that there is a God who directs this miraculous Matter of Light, rendering it fubject to fuch Laws, notwithftanding the amazing Velocity of its Motions, that even the greateft Mathematicians muft ftand aftonifhed, when they fee all that true Argumentation can deduce from it, performed by the fame. Thus we fee when it falls upon the Superficies of a Looking-Glafs, that it paints the Object from whence it flows upon the faid Looking-Glafs, where the Image is reprefented erect equally large, and at the fame Diftance as the Ob ject: If it falls upon Spherical Convex-Glaffes, it likewife makes behind the fame a nearer and direct Image upon the Glafs; and upon Spherical Concave Glaffes the Image will be fome:
fometimes direct, fometimes inverted, now greater, then fmaller; one while it will appear before, another while behind the Glafs, which may be fhewn almoft by Refraction in fo many Changes thro' Convex and Concave Glaffes.

Sect. XXXIX. A Dark Chamber, and ConviEtions from thence.

Now if any Body would with fmall Expence try an Experiment about the Operations of Light, let him make what they call a Dark Chamber, of which mention has been already made in Contempl. XII. by which means he will fee upon a white Paper, or a piece of Linnen held in the Focus of the Glafs that is fix'd in the Window, the Pictures of every thing that is on the outfide of the Chamber, which will produce a very pleafing Profpect, efpecially if the Chamber look'd upon a Flower-Garden; for then one might fee the Flowers in all their Colours, and Figures, painted upon the Paper, and their Motions occafion'd by the Wind; and if there be any Men or other Creatures in the Garden, it will be a natural Moving Picture.

> Sect. XL. The Properties of the Rays of Light, with refpect to Colours.

But before we take our leave of Light, we fhall add fomething which feems to furpafs even Wonder itfelf. Could any Body believe it, when he looks upon the bright and untinged Light of the Sun, that the fame can be divided and diftinguifhed into fo many different forts of tinged or dyed Rays, as the Great Creator has been pleafed to communicate of capital Colours or fimple

Tinctures,

Tinctures, or as the Learned call them, Homogeneal Colours?

And yet Experience teaches the fame, as allo that each of thefe coloured Rays fuffers a particular Quantity of Refraction, and that the white, or rather the clear Light, is thereby fplit into different Parts or Kinds of Rays, which appearing fingly, fhew a red, yellow, green, blew and purple Colour ; on which account there Rays are named by Sir Ifaac Newton, Red, Yellow, Ức. each of 'em according to their particular Colours, forafmuch as they are natusal to them, and cannot be altered by any fubfequent Refraction or Reflection.

Moreover, fince all unmix'd Rays of the Sun do reprefent a certain Colour, and the whole Subftance of Light confifts of the faid Rays, it feemed to be hardly poffible, but that all thefe Tinctures jumbled together, muft occafion an Obfcurity to our Sight; forafmuch as Blue, Purple, Red, and other Rays; are far fhort of that Brightnefs which occurs to us in the pure Light of the Sun or Day; and yet we find that all thefe colour'd Rays that proceed from Light by Separation, being collected and mix'd with each other, do entirely lofe their refpective Tinctures, and together produce a clear and tranfparent Light in all things, like that untinged Light that comes down to us from the Sun: Which new conftituted Light may be again, as before, divided into its coloured Rays, which, if one will, being mix'd together again, fhall the fecond time reprefent an uncoloured Light clear and tranfparent ; concerning all which, the firft Difcoverer, Sir IJaac Newron, has treated largely in his Opticks.

Now I ask an unhappy Atheift, whether he can believe that Light has acquired thefe Pro-

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perties either by Chance or ignorant Caufes ? Or whether he muft not acknowledge, that thofe Men argue much more juftly, who conclude from hence, that the great and gracious Benefactor of Mankind has produced all thefe differently colour'd Rays, to the end that the Beholder may be fo much more agreeably affected and refrefled with the Sight of his Creatures; and that he has placed in them the laft Property, whereby all of ${ }^{3} \mathrm{em}$ being mingled together do compofe a clear and tranfparent Light, to the end that the obfcurity of the Colours may not embarrafs Human Eyes?

Befides his Wifdom and Beneficence mult be acknowledged herein, that in the Parts which compofe different colour'd Bodies, he has placed fuch a Difpofition, whereby one Body when this compounded Light falls upon it, is adapted to reflect only one, or fome particular kinds of Rays; for Inftance one only Red, another only Yellow, a third both of 'em equally, and no other (by which a kind of a Gold-colour between Red and Yellow is generated) I fay, to reflect thefe in a greater quantity, by which means each Body according to one or more forts of Rays which it reflects, either Simple or Compound, reprefents its particular Colour, and from thence is denominated Red, Yellow, 6 c.
How ftrange foever this Language might have been to all former Philofophers, yet the fame is at prefent put out of all doubt by the afore-quated Opticks of Sir IJaac Nerwton; who tho he may be jufly reckoned by every Body among the moft famous Mathematicians of the World, yet to fet an Example to thefe lefs experienced Gentlemen, that they fhould not too much relie upon Conjefures and Hypothefes, las proved the fame to be unqueftionably true, not by Demonfrations foundẹd
founded upon Arguments, but by manifold and exceeding nice Experiments. Now thofe that have a mind to read and try the fame, may meet with 'em in the aforefaid Treatife of Opticks, efpecially in the Firgt Book.

## Sect. XLI. The Divifion of Light in IllandChryftal.

Besides the above-mentioned Divifions of Light, whereby it is fplit into various coloured Rays, Mr. Huygens in his Treatife about Light, p. 6 I. and Sir IJaac Newton in his Opticks, Query 25. p. 328. do fhew us another Divifion or Splitting of Light, which it undergoes when it meets with I/land-Chrytal; upon which as foon as a Ray of Light falls, it is divided into two other Rays that preferve however the fame Colour.

Of thefe Divifions or Splittings of the Subftance of Light into feveral other Parts, as well tinged in the firt Cafe, as fimple or untinged in the fecond, I don't know that there was ever the leaft mention made, or Track to be found among the ancient Naturalifts; nor that this Matter has been put out of doubt fooner than in the laft Age by accurate Inquiries and undeniable Experiments.

## Sect. XLII. The Ufefuluefs of the Moon.

Now let the Reader return with us to Tab. XXI. Fig. 4. and fuppofe the Sun to be reprefented by A B, and the Earth by C D, in which Situation, as we have faid before, the Shadow of the Earth, or the pyramidal Figure C P D makes the Night, it will not be then difficult for him to fancy the great Darknefs with. which thofe that dwell
dwell at $\mathbf{T}$ muft be involved; forafmuch as not the leaft Ray of Light flowing from the Sun A B, can come to them directly, or in a fraight Line.

Now if you will pleafe to oblerve, that the Moon $M$ being oppofite to the Sun $A B$, is at Full to thofe that live at T, that is to fay, they fee its whole enlighten'd Side: You will tell us whether you can think there is any Gratitude in thofe People that fhall deny their great Obligations to him who has furnifined them with this Light of the Moon in fuch their Darknefs.
$\mathrm{S}_{\mathrm{Ect}}$. XLIII. Convictions from bence, and the Eclipfes.
Now the only Evafion that fuch People can make, is, that all this happens by Chance, or by necefliary Caures, and confequently that no Thankfulnefs is due : But if the Gracious Creator of the Mcon had no Wifdom, nor the Benefit which Men enjoy from the Light thereof, is not to be reckoned one of his great Views and Defigns, how will they account for the following Particulars!
I. That the Light of the Sun has a Property when it falls upon any Bodies (as here from N , the Center of the Sun, uipon M the Moon) to rebound back from it again, and to produce a reflected Ray M T; by which means thofe that would otherwife remain in the midft of the dark Cone CPD, are enlightned. Now, that without this Faculty of Light, there could be no Rays reflected from the Moon to our Earth, is plain enough.
II. Why is the Moon M, which is much fmaller than the Globe of the. Earth, placed at no greater Diftance from it; fo that (as we fee in Saturn, and other great Plancts) its Breadth and Diameter

Diameter difappearing almoft out of Sight, would be uncapable to communicate any Light to us that could be ufeful? And is there here no wife Purpofe? And fince the Univerfe is fo large, why is this Place, among Milliens of others, juft chofen out, whereby it is beft befieted to render fuch Service to thofe who inhabit the Earth ?
III. How comes it, that the Moon is not of fuch a Contexture as our black or dark-coloured Bodies are ; by which means it would be able to give little or no Light to us?
IV. Why is it not a convex, globular and fmooth Body, like Looking-Glaffes and other polifhed Things; when (as thofe who underftand opticks know) there would be no more than one Point, or at leaft a very little part of the Moon vifible and capable of enlightning us?

V . Why does not the Moon move according to the Line G HFS, which lies in the Plane of the Sun's way $\mathrm{N} n$; by which means the fame at $G$ being oppofite to the Sun, would never be feen Full, but would always be obfcured and eclipfed by the fhadow of the Earth CPD, and on the contrary, the Moon being at F when it is dark or new, the Sun A B would be always either totally or partially covered and eclipfed thereby, at leaft the World reaps this Benefit by the Declination of the Moon's Way M HR S from the Plane of the Ecliptick, or Sun's Way $\mathrm{N} n$, or GHFS, that the Placeslying near the Poles may be enlightned by the Moon, whilft the Sun being ftill under the Horizon, occafions fuch a long and difmal Night?

And moreover, does there appear no Wifdom therein, by which this continual Monthly Sun (as one may call it) is fecured to the end, that Mankind may not be fo often deprived of the Ufe thereof ? How comes it then to pafs, that the Moon's

Moon's way SMHR has juft fuch an Obliquity with refpect to the Plane of the Sun's Way, or GHFS, that Firf the moft part of the time that the Moon is at M , or directly oppofite to the Sun, it is freed from the Shadow of the Earth CPD, and confequently from its Darknefs, and that all that part of it that is turned to us, is feen at Full, and in its entire Luftre : Secondly, That when the Moon is at R , that is, in Conjunction with the Sun, and is feen at $E$, it is not hid from thofe that dwell upon the Earth?
VI. But farther, fince now the Planes of the Sun's and Moon's Way H F S G and HMSR (placed in refpect to each other after the manner of two Hoops laid obliquely upon one another) cut each other at two Points H and S ; it follows, that when the Moon is not in its own Way at M, but at H or S , it will then be in the Plane of the Sun's Way : And when it happens at the time that the Sun is not at A B, but is directly oppofite at $a b$ to the Moon at H or S , and that the Sun and the Earth are in a Right Line $n \mathrm{~K}$; it may be eafily gather'd from the Figure, that when the Night-fhade extends itfelf to EK T , the Moon being at H , will be thereby eclipfed and obfcured; but when it is at S , it will then hide the Sun at $a b$, and fo caufe a Solar Eclipfe to thofe that dwell at S .

## $\mathrm{S}_{\mathrm{Ect}}$ XLIV. The Advantages of Eclipfes.

But here feems an Objection to ftand in our Way, namely, that if Light be fo agreeable and Darknefs fo terrible, and if all this be fo order'd by a wife Governour of the World, why do thefe Eclipfes or Obfcurities of the Sun or Moon come to pals, fince Light alone feems fufficient to fur-
nifh Man, tired by the Labours of the Day, with refrefhing Reft ?

Now to anfwer this, and to thew that in Eclipfes likewife, how dark foever they may be, the moft adorable Wifdom of God is difplayed, we need alledge nothing mote than what is already known to Aftronomers from the Ufes thereof.

And, Firft; that in the Inquiring into the Courfe of the Sun and Moon thefe vifible Signs are oft-times fo many Evidences, whereby we may know whether what has been faid thereupon, in other Cafes, is well grounded or not: Of this you may meet with many Inflances among the Aftronomers, which we fhall not here relate.

Secondly, They adminifter Proofs of many natural Truths, which might not have been difcover'd to us, without thefe Eclipfes, or at leaft not fo eafily.

Thus we know that the Moon is lefs than the Sun, or even than the Earth itfelf, without any Calculation, only from hence, that (Tab. XX. Fig. 2.) the Earth's Shadow A L Z running like a Pyramid into a Point at $L$, is for that reafon every where fmaller than the Earth itfelf; or the Line HK is always fhorter than the Diameter A Z of the Earth; and becaufe the Moon V; paffing through this Shadow, from H to K , is not only darken'd, but even remains frequently hid a long time in the fame; which 'tis plain would never happen, if the Moon were only of equal Magnitude with the Earth.

From whence it likewife follows, that the Moon in itfelf is a dark Body, at leaft it is far fhort of the Clearnefs of the Sun, even tho' we fhould afcribe to the Moon itfelf that Flame-Colour which it fometimes fhews in its Eclipfes, as many have thought.

From hence it alfo appears that the Moon receives its Light from the Sun; forafmuch as when it has paffed thro' the Earth's Shadow, and Penumbra after its Eclipfe, it appears again in full Luftre as foon as ever the Rays of the Sun can fall upon it.

Moreover, the Eclipfes of the Sun teach us, that the Moon is not only a dark, but likewife an untranfparent Body, which appears by its hiding or covering the Sun.

Many fuch Obfervations might be fhewn from thefe Eclipfes ; 'tis enough for us to have reprefented, fome of them, by which the Benefit thereof is proved in the Examination of the Creatures.

Yet if there be any Body that is not fufficiently convinced from hence, and it appears to him too fmall a thing, that the Inquirers into $\mathrm{Na}-$ ture are only benefited thereby (tho' the Honour and Wifdom of the Creator is beft fupported and magnified the fame Way) yet he cannot avoid owning the great Ufe and Service thereof in other Occafions alfo; for fince thefe uncommon Signs of the Heavens having been obferved by all, or at leaft by many Men for many Ages, have been accurately noted by fome, together with the Time when they happened; and forafmuch as thofe Times of the pait Eclipfes may be likewife determined by Pofterity with the Help of Aftronomical Calculations, it will eafily appear from hence, that thofe Eclipfes are, as it were, fix'd Land-Marks in the Series of Ages and Hiftories; from whence again, as from an undifputable Root of Time, a new Chronology may take its Date, and others in which there is any Uncertainty, may likewife be rectified thereby.

But the Ufefulnefs of the Moon's Eclipfes appeass yet more particularly in determining the Longitude of the Earth; infomuch, that the Truth
of many Maps and Defcriptions of the Earth may be examined and corrected thereby, as has oftentimes actually happened, which is not only of very great Advantage to Geographers, but likewife of the utmof Importance to fo many Sea-faring People, whofe Prefervation and Lives too often depend upon the Goodnefs or Badnefs of a Chart.

After having underftood this right, it does not feem neceffary to prove by more Circumftances, that the above-mention'd Objection will fall of itfelf, and that the Eclipfes of the Sun and Moon are of great Ufe to Mankind.

Befides, that tho' we fhould not be able to fhew all the Ufes thereof, yet this is no Proof of any thing's being unprofitable, fince fuch a Reafon has no other Foundation than in the Ignorance of Men.

Sect. XLIV. The Light of the Moon is without Warmth.

But to proceed: Is it not a Wifdom that has made and ruled the Moon with the Defign of doing Good to Mankind ; forafmuch as there is hardly any Light known to us which does not warm at the fame Time that it fhines; and fince the Rays of the Moon feems to be no other than thofe that are tranfmitted from the Sun to it, and then reflected back to us; how comes it that the Moon-Light was neither hot nor cold, even then when the Rays thereof were collected by a great Burning-Glafs into one Place or Focus, which (according to the Experiment of Dr. Hook, AEZ. Lip $/$ 1707. p. 153) was 500 times fmaller than what they filled in their natural State. Thus we fee likewife in the Experiment of Mr. La Hire, in the Memoirs of the Royal French Acndemy i 705,

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\begin{array}{ll}
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$$

p. 455 , that the Rays of the Full-Moon in OEtober, collected in the Focus of a Burning-Glafs of 35 Inches broad, and into a Place three hundred and fix times leffer than what the fame would have filled in their natural State, did not produce the leaft Alteration in a Thermometer which was moved by Air, and which difcover'd the fmalleft Increafe of the Warmth thereof, tho' the Ball of it was held for a . while in the faid Focus: And we likewife find by the faid $A \subset 7$. Lipf. 1697, p. 429, that the fo famous BurningGlaffes of Mr. Tfchirnhaus produced indeed a greater Brightnefs by the Rays of the Moon in the Focus, but not the leaft Warmth. Now could ever any Body have imagined that the Rays of the Sun collected by a Burning-Glafs, or reflected from the fame, will burn fo terribly; and yet that the fame Rays rebounding from the Moon to us, do not appear to bring the leaft Warmth along with them, notwithftanding that by this kind of Glaffes the Brightnefs of the MoonLight is very much augmented in the Focus as well as that of the Sun.

But we fhall have occafion to fay fomething more of this, when we come to the Contemplation of Unknown Things.

Now how advantagious it is to hot Countries, that this Light of the Moon produces no Heat, is obvious to every one who knows that if it was otherwife, and that the Rays of the Moon were likewife hot, that part of the Earth would be barren, and foon burnt up, fince the defcending Dews of the Night, by which it is now moiftned, would then ceafe to fall down, and this Fire of the Moon would draw its Vapouts upwards. Moreover, if the Night-Air were not frefher and cooler, and that the Rays of the Moon kept the fame in a continual Warmth,
it is plain enough how prejudicial it would be to the Health of all Men, and the hot Parts of the World would fuffer great Inconveniencies thereby.

Sect. XLV. The Moon's Magnitude and DiAtance from the Earth.

I K now not whether it is neceffary to fhew in this Place, how much the Moon is fmaller than the Earth, and how much the Light thereof (which in itfelf is hot, yet) by reafon of the Diftance is weaker, and lefs warm upon the Earth, than at the Moon itfelf. But fince the preceding Figures may be of ufe to us in this Matter, and the Grounds of this Calculation depend on that of the Sun, we thall briefly touch upon the fame.
I. Let A.B (as before in Tab. XX. Fig. r.) be the Semidiameter of the Earth, and D C now be that of the Moon; then will the Angle A C B of the Moon's horizontal Parallax, when the is New, or Full, according to Sir F. Newton, be at a Medium. ———— 57 Min .30 Sec. And its apparent Diameter?

DCG, according to the 31 Min. 30 Sec. fame.
The half of which therefore?
for the Angle DBC, is $\} 15 \mathrm{Min} .45 \mathrm{Sec}$.
In the Fourth or laft Quarter of the Moon; and at a middle Diftance likewife from the Earth, Sir F. N. again fuppofes,
The Horizontal Parallax or? the Angle A C B

56 Min. 40 Sec.
31 Min. 3 Sef: Angle D B G
The half of which for the An-? gle DBC is

15 Min. 3 S Seco
Ccc 3
Now

Now fince A and D are Right Angles, made by a Tangent and a Semidiameter, if we take the Earth's Semidiameter A B for an Unit, we fhall, by plain Trigonometry, find B C, or the Moon's Diftance from the Earth to amount to ;

At New or Full barely 60 Semidiameters of the Earth.
And at the Quarters, barely $6 I$ of the fame.
So that the middle Diftance is about $60 \frac{\pi}{2}$ thereof.
2. Now to difcover the Magnitude of the Moon ; we firft find its Semidiameter DC by Trigonometry aforefaid, amounting at Full or New to $\frac{-445}{5} \frac{4}{50}$ or $\frac{63}{230}$, and at the Quarters to ${ }_{\frac{9}{3}, 301}^{20}$ Parts of AB, or of the Earth's Semidiameter ; both which do not differ much from $\frac{3}{\frac{3}{5}^{3}}$ Parts of the fame.

From whence it therefore follows, That the Earth's Diameter A B, Is to that of the Moon CDAs about II To 3 ; Confequently the Body of the Earth Is to that of the Moon, As the Cube of In or 133 I To the Cube of 3 or 27 , according to what we have faid about the Sun. And therefore 27 Globes of the Earth, are equal to 133 Globes of the Moon, or the Moon is $49 \frac{8}{2} 7$, barely 50 times (to compute in Round Numbers) leffer than the Earth.

This Calculation is accurate enough to build upon in Things of fuch a Nature; and if it be not entirely exact, neither is it far fhort of the Truth.

With this likewife agrees the Conclufion of that Great Aftronomer Mr. Flamftead, who makes the Diameter of the Earth (as Mr. Whifon fays in his Pralect. Phy/fc. p. 292.) to amount to 7935 Englifh Miles, and that of the Moon 2175 of the fame: Which Proportion of 7935 to 2175 , varies but little from the above-mentioned of 1 I to 3 .

Sect. XLVI. Why the Light of the Moon is not Warm.

Now if we fuppofe the Point $S$ in the Moon, and the Point B on the Earth, (Tab. XXI. Fig. 2.) and farther, the Length $S b$ as the Moon's Semidiameter; and if we look back upon what has been faid above concerning the Diverging and Spreading of Light at various Diftances, as well with refpect to its Heat as Shining ; we fhall find that in both thefe Cafes the Force of the Light at $b$, Is to that at B, As the Square of S B, To the Square of $S b$.

Now we have fhown above, that as S B is $60 \frac{\pi}{2}$ Semidiameters of the Earth, or the Moon's Diftance; fo $S 6$ is $\frac{3}{T T}$ parts of one Semidiameter of the Earth, when it reprefents that of the Moon.

Now $\frac{9}{12 T}$ is the Square of $\frac{3}{1 T}$ or $S b$, and $3660_{4}^{\frac{x}{4}}$ that of $60 \frac{1}{2}$ or S B ; and confequently the Firft is to the Second, As 9 To $442890_{i}^{1}$, or, As I To 492 10, omitting the Fraction. From whence it appears, that the Warmth of the Light which comes down from the Moon, is about 50,000 times lefs when it has reach'd us upon the Earth B, than it is at the Point $b$, when it has proceeded no farther than the length of one Se midiameter of the Moon, or S $b$.

And this is the Reafon, according to Mr. Whifton, Pralect. Aftron. p. 108. why the Light of the Moon is not attended with any fenfible Warmth by the time it has reach'd us here upon Earth. But forafmuch as Dr. Hook has collected the fame into a Space 500 times fmaller, and confequently render'd it 500 times as ftrong as the faid Light is in its natural State; and therefore in fuch a Focus it is no more than 500 times weaker than at the Moon itfelf; yet, even in that safe this LeamCcc 4

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ed Man could not perceive any fign of Warmth, notwithfanding that the Shining or Light of the Moon (which deferves to be taken notice of) was increafed proportionably. I leave it to the Judgment and Obfervations of others, whether $\underset{\tilde{T}-\mathrm{a}}{\mathrm{T}} \mathrm{a}$ part of the Warmth of a hot Summers-Day with us, would be able to make any Impreffion cven on the beft Thermometer: For that the Rays of the Sun have much the fame Power on the Moon, as on the Earth, is plain enough from the little difference there is of both their Diffances from the Sun.

And in this Experiment the Thermometer being moved by the Light of the Sun, it fhould feem that we are obliged to feek for fome other Caure than the fimple Diftance, to which we fhould afcribe, that the Light or Rays of the Sun are reflected to us from the Moon, without bringing any Heat along with them, but leaving it all behind them.
Be that as it will, this is plain, that if the Moon fhould tranfmit to us fo much Heat with its Rays, we fhould fuffer many Inconveniencies from thence; which is now prevented by our great Creator, who directs all Things with infinite Wifdom and Order.

## S $_{\text {вст. XLVII. The Cauje of Ebbing and Flowing }}$ not inquired into.

Now whether the Moon is the Caufe of the Ebbing and Flowing of the Great Seas, and of the continual Motion of their Waves to the very bottom thereof, we fhall neither difpute nor inquire into here ; becaufe we are not yet fo far advanced in this Knowledge, as to be able to fay any thing concerning it that may be free from every ones Objections, tho we feem to be very far advanced in that Matter.

This is experimentally true, that the Waters in the deep and free Seas (without taking notice here of other Impediments, concurring Caufes and Circumftances) rife and fwell up to the Places, or about thofe Places where the Moon is vertical, juft as if they were driven thitherward by a Weight, or attracted or preffed by fome other Power. Concerning which may be confulted the Writings of Kepler, Newton, Gregory, Whifton, Varenius, de Stair, \&zc.

We find the fame happens likewife on the oppofite Side of the Earth; wherefore the ufual Expreffions in which both thefe Appearances are comprehended, is, that when the Moon paffes to the Meridian, the Water rifes; when it goes away from thence, it falls. Others fay, that it is certain by Obfervation, that the Water is at highef about three Hours after the Moon has been in the Meridian. See Newton's Princip. Lib. III. Sect. 24. and Whifon Pralect. Phyjc. Math. Sect. 96. P. 306.

Let this Matter be as it will, it is certainly true by Experience, that if the Earth were cover'd all round with Water, it would appear Oval, by reafon of the Swelling of the watry Surfaces on each Side; and thefe two Protuberances of Water or Mountains, as Dr. Gregory terms them, move continually round about the Earth, if they be not obftructed by Land, Shoals or otherwife.

And as for that very ingenious Caufe and Figure which Defcartes produces, and whereby he would fhew that it is always ebbing Water upon the Earth directly under the Moon; Varenius fays in his Geography, Lib. I. Cap. I4. Sect. ir that the fame is contrary to Experience, and fo it has been found.

However, leaving the Caufe to every Man's own Opinion, this is the manner in which we muft fuppofe the Motion of the Sea-Waters to happen; namely, that it is a Swelling and Sinking bing and Flowing, according to the vulgar Notion thereof. See concerning the Alteration of thefe Expreffions, Varenius in the fame Place, Sect. 10. and Gregory Lib. IV. Sect. 65.

## Sect. XLVIII. Two Syftems of the World.

There are two Syftems of the Heavenly Bodies, which at prefent pafs for the chiefeft, and according to which they are fuppofed to be moved. The firft feems to be the moft convenient with refpect to the annual Courfe of the Planets, and is by many taken to be the true one, on account of its Simplicity: ${ }^{\text {'Tis }}$ that which we are wont to afcribe to Copernicus, who has revived the fame from the Ancients.

They that would form a general Notion thereof, may fuppofe, (Tab. XXII. Fig. I.) that the Sun fands ftill, and all the principal Planets move about it, according to the Orbits which they defcribe in this Figure. D is Mercury, the neareft to the Sun; C is Venus, next to and without which follows the Earth A, which upon this occafion is reckon'd among the Planets, and about which the Moon B runs; E is Mars, F Fupiter, which has four Moons moving about it, after the fame manner as Saturn $\mathbf{H}$ has five, and it may be fix; and both of 'em carry their refpective Moons about with them round the Sun. Beyond all thefe are the fixed Stars A P O X.

The Second Syftem bears the Name of Tycho Brabé, and feems in relation to the Planets, to be nothing elfe but the former a little varied in one Cafe only; and for no other Reafon than becaufe that of Copernicus fuppofes the Earth to move about the Sun, and confequently feems to contradict the Scriptures, from which Tycho and his Followers make a Scruple of departing.

To underftand this Syftem, we muft imagine that the Earth A (Tab. XXII. Fig. 2.) ftands ftill, that the Moon B runs round it ; that next to it the Sun $S$ defcribes its Courfe, and that all the Planets, with their afore-mention'd Moons, bear the fame refpect to the Sun, as in that of Copernicus: So that the Way of each of 'em furrounds the Sun, which continually moves about the Earth; and that all of them muft be confider'd as fimply moving about the Sun. The fix'd Stars are here likewife reprefented by A POX.

In both of 'em there is yet this Difference, that in that of Copernicus (Tab. XXII. Fig. I.) the Sun S and the fix'd Stars A P O X, ftanding as it were fill, the Globe of the Earth A really turns round its own Axis, from Weft to Eaft, in 24 Hours, by which means the whole vifible Firmament, Sun, Planet and Stars feem daily moving from Eaft to Weft.

In Tycho's Syftem, (Tab. XXII. Fig. 2.) nothing ftands ftill but the Earth A; whilft all the abovemention'd Bodies are fuppofed to run round daily from Eaft to Weft, befides the Courfe of each in its own Way from Weft to Eaft. What Reafons may have induced other Aftronomers to form one Syftem from thefe two, I know not ; fince in that Semitychonic, the Simplicity and Convenience of the Firft, and the Agreement of the Second with the holy Scriptures, feem to be, if not quite loft, at leaft very much alter'd; for which Reafon we fhall fay nothing of this latter, neither fhall we diffwade any one that likes it, from embracing it, fince we don't here undertake to difpute the Truth thereof, but endeavour to reprefent to Sceptical Philofophers, fo much as we know to be true of it from Experience and unqueftionable Calculations, in hope to convince them thereby shat there is a God.

Sect. XLIX. The Immenfurable Magnitude of the $^{\text {ect }}$ Fixed Stars.

To come then to the Matter : Let thofe who still doubt of a Powerful and Wife God, lift up their Eyes with us, and fuppofe this to be the firft Time of their Life that they ever faw the Hearens adorned with fo many Glorious Lights; and tell us, whether they fhould not be thereby convinced that the fame had a Mighty Creator, and that it was not by meer Chance that they had acquired their Origin and Luftre, no more than a Locket fet with Diamonds, of which the moft obdurate Atheift would not dare to affirm, that they were put together without the Skill of an Artificer; much lefs would they affirm it of the Heavens, efpecially if they obferve the immenfurable Magnitude thereof, which is fuch, that the Aftronomers have not been able hitherto to communicate any thing to us that can be more depended on than meer Conjecture; nor have they been able to anfwer all the Queftions concerning the Magnitude and Diftance of the Fixed Stars.

Thus we hear the great Obferver of the Heavens, Mr. Huygens, in his Cofmotheoros, p. 135. ingenuoufly acknowledging the fame in the following Expreffions: But thofe who before ns have endeavour ${ }^{\circ} d$ to determine this immenfe Space, bave not been able to conceive any thing certain, by reafon of the great Exactnefs neceffarily requifite in the Obfervations, and which exceeded the utmoof Care and Diligence; for which reafoin the Method I have now chofen, feems to be the only one remaining, in order to attain to fomething that might be at leaft probable in a Matter of fuch difficult Inquiry: Of which he gives the Reafon a few Lines after, in this manner: The Stars alfo of the firf Mag-

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situde, tho' view'd even by a Telefope, appear all So little, that one would take 'em for little lighted Matches without any Breadth, which is the Caufe that no Meafure of their Bignefs can be found out by this fort of Obfervation.

It will not be neceffary to produce any other of the modern Mathematicians who are of the fame Opinion, after the Teftimony of an Aftronomer, towhom the utmoft Efforts of all the famous Men of Learning were well known, he being a Member of the Royal French Academy, and not only in himfelf a Difcoverer of new and never before feen Lights and Phenomena in the Heavens, but likewife of an indefatigable Zeal, and abundantly bleffed with a temporal Eftate, whereby he was enabled to make Experiments of all Things.

The Method which that great Philofopher took, in order to form fome probable Conjectures concerning the Diftance of the Stars, fuppofes however, that which has no certain Foundation, namely, That a Star (at leaft one of the firft Magnitude, fuch as Syrins, or the Great DogStar) is as bigas the Sun ; from whence he infers, That the Diftance of the Stars from the Earth is 27,664 times greater than that of the Sun from the faid Earth: See his Cofmotheoros, p. 137. notwithftanding that he allows this laft to be above 12,000 whole Diameters of the Earth.

## Sect. L. Of the Parallax of the Fix'd Stars:

Another Method of inquiring into this Diftance with greater Certainty (if the Event had been favourable) has been fince fome Years fet on foot by Meffieurs Flamftead and Hook, who thought that they could deduce from their Experiments, that the Diameter of the Earth's made fome Alteration of Sight with refpect to the fix'd Stars, in Proportion as the Earth was fo much nearer, or fo much farther from them; whereby likewife the Syftem of Copernicus of the Earth's Motion, feemed to be proved at the fame time. I fhall not here rehearfe the differing Notions of Gregory, Whifton, and others, about the fame; but that from thefe Obfervations, even tho' they were true, the Diltance of the Stars and Motion of the Earth cannot be proved, is fufficiently fhewn by Mr.Cafsini, in the Hijtory of the French Academy for the Year 1699.

So that thefe two laft Methods, in which all imaginable Helps, known to the Moderns, are ufed, leaving the Matter ftill uncertain, there is no great Hopes of meeting any better, at leaft fince the Globe of the Earth is no bigger, or (according to Copernicus) its Way about the Sun of a larger, that it may the better ferve for a Foundation for fuch an Admeafurement. Now as long as the Diftance of the fix'd Stars from the Sun or from the Earth remains unmeafurable, it follows from thence, that the Magnitude of the Starry Heavens, tho' one were to confider it as an Orb about the Sun or Earth, which cannor yet be proved from Nature, will always remain likewife immenfurab'e.

Sie c t. LI. Whether the Starry Firmament be Solid or Fluid.

Now fince fuch great Mathematicians have with fo much Ingenuity owned themfelves unable to meafure the fo vaftly extended Magnitude of the Starry Heavens, which does in a manner furpafs all human Imagination, how great Progrefs had there been perhaps made in the Science of

Nature, if the Philofophers had behaved after the fame manner, with refpect to the Matter and Figure of which this Starry Heaven confifts, and if they had made the beft ufe of that Time which young Learners employ in uncertain Conjectures and Hypothefes, withoutiany Foundation, in making new and material Obfervations ? Since it remains a Myftery to the greateft Aftronomers, how the heavenly Bodies are framed and conftituted. Defcartes fuppofes 'em to confift of fluid Vortices, as is well known. Sir IJaac Nerwon, in his Scholium to the 53 Propofition in the Third Book, fhews the contrary ; and farther fubjoins, that this Hypothefis is inconfiftent with all Aftronomical Appearances; concerning which Mr. Huygens may likewife be confulted in his Cof motheoros, from p. 139 quite to the end, and in other Places; not to mention any more.

## Sect. LII. Probable Reafons for its being Solid.

The Foundation of thefe Opinions, that the Heavens are a folid Body, is principally, That the diftance of the Stars from each other has remain'd in a manner the fame without any Alteration for fo many Ages, which feems more agreeable to the Nature of a folid Matter, in which they are fuppofed to be placed, than in a Fluid.

This Conclufion feems likewife to be made with fome kind of Probability, from the wonderful Obfervation related by Mr. Huygens in his Syft. Saturn. p. 8 and 9, and which we don't know to have been taken notice of by any one before : His Words are as follows: "Aftronomers place "three Stars clofe to each other in the Sword " of Orion; and when I view'd the middlemoft " with a Telefcope, in the Year 1656, there ap" peared in the Place of that one (which is no

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" new thing) twelve other Stars, after the mant
" ner as they are reprefented in Tab. XXIII.
" Fig. I. Among thefe, three that do almoft touch
"c each other, and four more befides, appeared
"twinkling as thro" a Fogg; fo that the Space
"about ${ }^{\mathrm{em}}$ feemed much brighter and lighter
" than the reft of the Heavens, which appearing
" wholly blackifh, by reafon of the fair Weather,
" was feen as through a certain Opening and Se-
" paration, thro" which one had a free View into
" another Region that was more enlighten'd. I
" have often obferved the very fame thing with this
" without any Alteration, and in the fame Place;
" fo that it is likely that this Wonder, whatever
" it may be in itfelf, has been there from all
"Times; but I never took notice of any thing
" like it among the reft of the fix"d Stars; for we
"do not find that the others, which were for-
" merly accounted cloudy (Nebulofa) nor the
" Milky-Way itfelf, have any Mift or Vapour
" about 'em ; nor if we view them with a Tele-
" fcope do they appear to be any thing elfe thian
" a Collection of many fmall Stars.
Now I leave it to the Judgment of an impartial Perfon, whether one has not more Reafon from thefe Experiments, to believe, that the flarry Heavens do rather confift of a folid Matter, than a Flood of Particles continually moving among each other; fince the aforefaid enlighten'd Opening fhews itfelf circumfcribed, after the fame manner, which in fluid Masters, that are fo fufceptible of Motion, can hardly be expetted.

Sect. LIII.

## $\mathrm{S}_{1} \mathrm{EcT}$. LIII. The amazing Greatnefs and Diftance of

 the Stars:Now to proceed: As this great vifible Fir* mament is immenfurable, on account of the almoft inconceivable Extent of the Diftance thereof, fo likewife muft we look upon the Remotenefs of the Stars, and the Magnitude of thofe Bodies, as things uncapable of being determined by Men : The Reafon is, becaufe the Diameter of the Earth is to that of a fixed Star, As the Horizontal Paralax To the apparent Diameter of the fame. Now it is plain by Experience, that the Earth, and even according to Copernicus, the Diameter of that whole Circle, which it makes about the Sun, muft be confider'd only as a Point, with refpect to the Diftance of the Stars ; and mach too fmall to produce any Parallax. Befides; we likewife find, that the bef Telefcopes that are made, can only reprefent the faid Stars as fo many Points of Needles, and without Breadth, infomuch that we can't difcover any Meafure of the appatent. Diameters thereof by the Help of thofe Inftuments; fo that from the Impoffibility of obferving the Parallax, and efpecially the apparens Diameter, we are entirely difabled from determining the Magnitude of thofe Stars.

Now whether, with the modern Aftronomers, we are to confider every one of thofe Stars, at leaft all thofe of the firft Magnitude, luch as the Dog-Star, and the like, as fo many Suns, both in Splendor and Bignefs, has not yet been proved by any one: This is certain, that they are immeafurably remote from us, and that in so unconceiv able a Diftance they derive a native Light down to us; as alío, that if the Sun were as far from us.

[^2]it would not appear bigger than one of thofe Stars.
If therefore, without infifting upon a real Proof, we fuppofe thofe Stars to be fo many Suns from the Strength of their Light, and from their great Diftance (in which we do but follow, if not all, at leaft the greateft Aftronomers) we fhall have an Idea of the Heavenly Bodies that includes in it an amazing Greatnefs.

According to this manner, the Conjetures of Mr. Huygens will not appear ill grounded, who, upon the Calculation laid down in his Cofmotheoros, P. 136, and 137. makes the Diftance of the fix'd Stars from the Earth 27,664 times greater than that of the Sun. So that if, according to what we have faid before, a Cannon-Bullet will require 26 . Years in paffing from hence to the Sun, with the fame Velocity wherewith it was difcharged, it would require, in order to arrive at the fix'd Stars, 25 times 27,664 , that is, 691,600 , or almoft Seven hundred thoufand Years ; and a Ship that can fail 50 Miles in a Day and a Night, will require $30,430,400$ Years. And if we proceed farther upon this fame Foundation, and fuppofe, with thofe Gentlemen, that each Star has a Space about it proportionable to that of the Sun, I leave every Man to judge, whether he be able, without a great deal of Pains, to form to himfelf a juft Idea of this wonderful Extent of the Univerfe, and whether he be not in danger of lofing himfelf in the Contemplation of fo unconceivable a Greatnefs of fo glorious a Structure, in which the Footfeps of the Divine Builder do fo manifently appear. I have chofe rather to make ufe of this Hypothefis of Mr. Huygens, preferrable to others, becaufe nothing elfe is laid down by the fame, than that one
of thofe great Stars are like the Sun, and that the Splendor and Light of the Sun, when its Diameter is contracted according to the aforefaid manner, will be only equal to that of the Dog-Star ; but whether this be true or tio, yet it is beyond all doubt that the fix'd Stat's are very great, and that their Greatnefs and Diftance is not to be determinted, firice the manner of inquiring into it can hatdly be carried farther, according to the Opinion of great Mathematicians: See Gregory Schol. Prop. 55. Lib. 3.

## Sест. LIV. Convictions from the foregoing Otfervations.

I Havie oftentimes mof ferioufly reflected upon this Impolfibility of determining the Magnitude and Diftance of the Stars as an Effect of the adorable Wifdom of their Great Creator ; who knowing, that if they were capable of being medfured, how great foever the Extent thereof might be, yet from the Habitude and Cuftom of mentioning the farme, the Wonderfulnefs thereof would be much diminifhed : He therefore thought it nēceffary to make them immenfurable, and to put them out of the Reach of ail human Endeavours; and likewife, to the end that thofe who defpife him might be forced in fipight of all their kicking againft it, to conféls a Power to which they could fet no Bounds; and fince all their Learning could never fathom it, to live in a continual Aftonifhment at it, as it happens mof commonly in felation to things that pafs our Uriderfanding.

Sect. LV, and LVI. The Stars Numberlefs, and Convictions from thence.

A t leaft the Divine Authority of the holy Scriptures is evident from hence, by which, even from the firlt Ages of the World, the Magnitude of the Stars are determined to be abfolutely infcrutable, and confequently fhewn even then where the Efforts of Men in following Ages fhould find their Bounds, notwithftanding their utmoft Endeavours to the contrary. The Places upon which we have our Eye on this Occafion, are the Words of Fob, chap. ix. ver. 9,10 . where having firft faid of the fixed Stars in the 9 th Verfe, which maketb Arcturus, Orion, and Pleiades, and the Chambers of the South, he continues in the roth Verfe to fay, which doeth great things paft finding out, yea and Wonders without number. From whence not only what has been faid before, of the Infcrutability of the Stars Magnitude may be inferr'd, but likewife, in order to prove the infinite Knowledge of that Spirit, by whofe Infpiration this Word is written, more plainly againft all Unbelievers, we find it likewife litterally expreffed, that thofe Stars are not to be number'd, which could not have been irrefragably proved before our Times againft any one that would have denied the fame. Befides the above-quoted Text, this Innumerability of the Stars has been likewife afferted in feveral other Places of Scripture: Thus God fays to Abrabam, in Gen. xv. 5. Look now toward Heaven, and tell the Stars, if thou be able to number them; and he faid unto him, So faall thy Seed be. And the Almighty does frequently make ufe of the fame Comparifon to exprefs the infinite Number of the Cbildren of Ifrael, viz. Exod. xxxii: 13. Deut. i. 10.-x. 22. -xxviii. 62 . Neb. ix. 23 .and feveral pthers; befides,
that
that thefe thoufands of Ifraelites are oftentimes compared likewife with the Sand of the Sea, as in IJaiah x. 22. Hofea i. 10, Orc. from whence it appears at the fame time, that the Number of the Scars is not only made as great, but likewife as innumerable as the Sands of the Sea, in the faid Holy Scriptures.

Now it is known to all Aftronomers, that in order to pronounce fuch a great Number of Stars innumerable, or to compare the Number of Abraham's Children thereto, they could not be feen in theHeavens whilf they had no Ufe of Telefcopes.

Hipparchus, in his Catalogues of Stars, has tranfmitted to Pofterity the Number of 1026; which, in our Age, has been increafed to 1888, by the great Aftronomer Hevelins; among which are to be reckon'd 950 that were known to the Ancients, 603 which he calls his, and 335 obferved by Dr. Halley in the Southern Parts of the Heavens, of which Dr. Gregory treats more largely, Lib.ir. Secz. 29. but after that the Telefcopes had difcover'd that the great broad white Streak extending itfelf round the whole Heavens, and which, upon the Account of its Whitenefs, they call the Milky-Way, was formed of a Collection of numberlefs little Stars, which Dr. Halley likewife teftifies of the Southern Magellanic Little Clouds; See Gregory, Lib. 1 1. Sect. 22. After that, as it appears from the afore-cited Place of Mr. Huygens, for one Star that we fee with our naked Eyes, feveral others offer themfelves to the Telefcope; fo that according to the Remarks of Cherubin d'Orleans, p. 270, and 313, by the Help of the fame, in the only Conftellation of Orion (commonly called the Giant) more Stars, and according to the Obfervations of Rbeita, related by Zabn, Fund.III. p. 209. twice as many fhew themfelyes, as are feen by the Eye only in the whole

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Heavens:

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Heavens: I fay, fince thefe Telefcopical Obfervations, Aftronomers have loft all hopes of ever fixing the exact Number of the Stars, the rather, becaufe the more thofe Telefcopes are improved, the greater Number of Stars are feen; infomuch, that fome, tho' without Foundation have maintained, that the Number of the Stars is infinite, as Mr. Huygens witnefles of Fordanus Brunus in his Cofmotheoros, p. 138; but to fay nothing more than what is true, this is certain, that the modern Obfervations made by the help of thefe Infruments does fufficiently evince, that the Stars are not be counted. See Whilton. Pralect. Affron. p. 23.
Now let an Infidel tell us how it is that $M_{0}$ fes and Fob, if they had not been Divinely infpired, could in their Times have pronounced the Stars to be innumprabie, fince it was fo many Ages after, that this exceffive Multitude upon the difcovery of Telefcopes, has been experimentally known to Mankind.

## SE c т. LVII. Whether the Stars differ in Magnitude.

Now if we inquire into the Opinions of the greateft Mathematicians concerning the difference of Stars from one another, we find the moft able of 'em ingenuoufly confeffing, that it is perfectly unknown to them, whether allithe Stars are of equal bignefs; infomuch that it is doubtful whether fome of 'ern appear fmaller only upon the account of their being farther diftant from the Eye, or whether one Star is really bigger than another.

The Apofte Paul does pofitively determine the Matter in thefe Words, i Cor. xv. 4. One Star differeth from anotber Star in Glory; and if I may beallowed to add fomething by which that Saying of the Apofle feems to be verified in fome man-
ner from Nature, I defire the Reader to confider with himfelf, whether it be not more credible, that one Star is bigger than another, than that they fhould all be of the fame bignefs, and at different Diftances; fince we find by the Obfervations of the greateft Aftronomers, that it is certain enough that fome Stars have plainly alter'd their Magnitude, and become fmaller : (See an account thereof in Gregory, Lil. II. SeEt. 30.) for I cannot believe that any Body will afcribe this only and entirely to their removing to a greater Diftance. Yet if fuch a thing could happen, he may be pleafed to pafs this Reflection by, tho otherwife the different Magnitude of the Planets feems in fome manner to lead to fuch an Opinion.

Sect. LVIII. Alterations in the Fixed Stars.
Before I proceed any farther, I cannot forbear upon occafion of what we have already mention'd, to fay fomething of what has been obferved in the Heavens, with refpect to the Stars about an Age ago, and which has aftonifhed all the Aftronomers. Mr. Whifon in his Pralect. Aftron. p. 47. names it a very great and afonilhing Wonder, that muft be tranfmitted or left to following Ages, zuithout our being able to give any Solution thereof.

That which is meant here, are thofe Alterations among the fixed Stars, that are ftill unintelligible to us, whereby we find that fome new ones appear, and others that have been feen, do difappear; and a third fort fhew themfelves one time with more and another time with a leffer Luftre. Hipparchus is faid to have obferved one ; but in the Year 15.72, we know that anew one appeared in the Chair of Cafjopen; in 1600 in the Bieaft pentanius; and feveral others may be found in Gregory, Lib. II. Sect. 30. as alfo in Mercator and Whifon, that give us an account of them and their Number. Some again, that had been feen before, are now invifible; and Hevelius fays, in his Pracurfor, that they fought in vain for five Stars, whofe Places however Tycho Braché had defcribed full an Age before: Concerning which the faid Gregory gives us a farther account in the ACt. Lipf. 1691. p. 80. as alifo how a Star belonging to the Neck of the Whale has often difappeared, and fhewn itfelf again in the fame Place at different times; See ACt. Lipf. 1703. P. 213 . and how their Magnitude is remarkably changed in others, at leaft with refpect to their Light. The Reader may likewife note what has been mention'd concerning Kirchius in the aforefaid Tranfactions of Leipfick, 1687. p. 647, fince we cannot ftand here to reckon up all thofe Particulars.

## Sect. LIX. Concerning the Planets.

Let us now proceed to the Planets or Wandering Stars, fo called, becaufe they appear to us who live upor the Earth A, (Tab. XXII. Fig. 1, and 2.) to more fometimes quick, other-times flow ; now forwards, then backwards, and another while toltand fill for a time; which, to thofe that have not inquired inte their Courfes, looks like Wandering; tho thofe that do underftand it, know, that with refpeet to the Sun they only proceed forwards, but yet occafion the fame Appearances, for which the Aftronomers have accounted.

All the Planets, as we have faid before, do move qbout the Sun $S$ but two, which are therefore filed the loweft, vizo Mercury D, and Venus C, perform
perform their Revolution in fuch a manner, that as they are ofeen from the Earth, they appear always on the fame fide with the Sun: Whereas the three other, Mars E, $\mathcal{F u p i t e r}$ F, Saturn H, are feen from the Earth $A$, fometimes on the fame fide, and fometimes on the oppofite fide of the Sun, as you may obferve on the abovemention'd two Figures of this Table.

Now in order to form a right Notion of thefe Planets, we muft again endeavour to diveft our felves of thofe Prejudices which we have fuck'd in as it were with our Mother's Milk, and by which we are taught to imagine, that thefe great Bodies are about the fize of the Marbles we play'd with when we were Children, or fomewhat lefs, and that they are but a very fmall Diftance from us; and we are yet the more confirmed in the fame, by the Figures that Aftronomers are wont to give us of thefe Planets, which at the beft do reprefent to us the Proportion of their Diftances, but in a very fmall Compafs, and do rarely or never fhew us their Bodies in comparifon of their real Magnitudes, which likewife confiderably helps to prevent our Conceptions thereof.

## $\mathrm{Sect}_{\mathrm{ec}}$ LX. The Magnitude of the Planets.

That famous Aftronomer Mr. Huygens, in order to improve our Notions concerning the Planets, did at the latter end of his Life draw their Magnitudes in a particular Figure in proportion to that of the Sun, which we have therefore trannferr'd from his Autom. Planet. to our Tab. XXIII. Fig. 2. where the Earth A, and the Moon by it at B , and fo the relt of the Planets are reprefented in their proportionable Bigneffes with refpect to the Sun G D K. According to his Obfervations be,
110 times greater than that of the Eartb A. 308 ——-than that of Mercury D.
$8_{4}$ - than that of Venus C.
166 ————than that of Mars E
$5 \frac{1}{2}$ ————than that of Fupiter F. ${ }_{3}^{2} \frac{4}{2}-\cdots$ - than that of Saturn's Ring G I. and that of the Ring $2^{\frac{1}{4}}$ times bigger than the Diameter of the Globe of Saturn $\mathbf{H}$.

From whence it follows, if thefe Planets are compared with the Earth, which is beft known to us,
I. That the Eart bis not quite 3 times fo thick, and confequently not quite 27 times as big as the Planet Mercury D.
II. That Venus C is about $\mathrm{I}_{\frac{1}{3}}$ as thick, and confequently as big as the Earth itfelf.
III. That Mars E, is fmaller than the Earth, fo that the Diameter of the latter will make $\mathrm{I}^{x}$ of the former, and confequently contains $3^{\frac{3}{5}}$ as much Matter as the Globe of Mars.
IV. That fupiter F , has 20 times as great a Diameter, and 8000 times as large a Bulk as that of the Earth.
It has likewife four Satelites or Moons about it, each of which does not feem leffer than the whole Earth : See Huygens Cofm. p. ror.
V. After thefe come Saturn H, which, what no Body could ever have thought or furpeEted, is furoounded with a Ring GI, that is flat and very thin in proportion to its Magnitude: There is a Space between that Ring and the Body of the Planet, which it encompaffes without any Contiguity like a Vault or Ceiling ; for which reafon this Difpofition of Saturn with its Ring, being viewed from different parts of the Earth, is wont to reprefent a very different Figure. The Diameter

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of this Ring G I, is according to the foregoing Computation about 30 times as large as the Diameter of the Earth, and therefore if it were a Globe, it would contain about 27,000 times the quantity of this Globe of the Earth.

The Diameter of Saturn itfelf is about is times as big as the Earth's, and confequently the Body of that Planet is 2197 times as large as the whole Earth; befides which there are five Moons that are obferved to circulate about the faid Planet and its Ring.

SECT. LXI. The Times of the Planet's Revolutions and Diftances from the Sun.

Now the Times in which thefe Planets finifh their refpective Circulations about the Sun, have been obferved as follows: That of Mercury, in three Months; of $V$ enus, in about $7^{x}$ Months; of Mars, in almoft two. Years; of Fupiter in 12 Years; and that of Saturn, in about 30 Years, all of 'em computed as near as may be.

We fhall here pafs by the Satellites; they who defire to know the Time of their Revolutions about Jupiter and Saturn, may confult the Aftronomers.

The Diftances of thefe Planets from the Sun are likewife reckoned in the following manner: Upon the fuppofition that the Diftance of the Earth from the Sun is 10, that of Mercury is hardly 4, Vemus 7, Mars 15, Fupiter 51 , and Saturn 95 of the fame 'Parts: See Gregory Aftron. Lib. I. Sect. I. So that the Diftance of our Earth from the Sun being, according to Caffini and FlamAtead (for the more convenient Calculation) 10000 Diameters of the Earth; Mercury will be 4000 ; Texus 7000 ; Mars 15000; Fupiter 51000 ; and Saturk 95000; and propertionably fo much greater

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greater if with Mr. Huygens we account the Diftance of the Sun to be 12000, or with Mr. la Hire 17000 of the faid Diameters. We have here ufed the fmalieft Numbers, becaufe we would proceed with the greater Certainty.

Sect. LXII. The Velocity of Venus and Jupiter.
Now let the Atheift confider, that notwithftanding the contemptible Notions he has of there Heavenly Bodies, which he looks upon as no bigger than they are reprefented in Tab. XXII. Fig. 1, and 2 ; and in Tab. XXIII. Fig. 2. yet Venus, the Evening and Morning Star, is a Globe not much fmaller than that of the Earth; and, which is amazing, it moves about the Sun with a Swiftnefs, 146 times greater than that of a Bullet, fhot out of a Cannon. To give likewife an Inftance of one of the remoteft Planets, let him contemplate that of Fupiter, which is a Globe 8000 times as big as this of the Earth; and let him confider, Firf, how great a Diftance it muft be from him, when fo vaft a Body fhall appear as finall as one of our Childrens Marbles: And Secondly, what a Force is neceffary to move fuch a prodigious Globe along the Heavens, the Motion of which we find to be 54 times fwifter than a Cannon-bullet's.

Sect. LXIII. The Calculation of the Revolutions of the aforefaid Planets.

This may perhaps feem fomewhat whimfical and incredible too to ignorant Perforts; but thofe who underfand Aftronomy know that nothing need be advanced by Conjecture or Gueffing, when one compares the Magnitude and Di ftance of the Planets with that of the Sun; but

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that the fame may be deduced by certain Confequences from the Obfervations that have been made concerning them, as every Mathematician knows, and as literally appears in the Syf. Saturin. p. 77 and 8 I , of Mr. Huygens; fo that upon the whole Matter, it depends only on the Greatnefs and Diftance of the Earth with refpect to the Sun, not to know the Proportion only, but the true Meafure thereof, of which Aftronomers are in a manner fo much Mafters, that they can be fure that neither the Planets themfelves nor their Diftances are fuppofed too great.

If it be then known that there is no Miftake of any Importance made herein, the fwifnefs of their Motion may be eafily computed from the time of their Revolution : As for Inftance, a Can-non-bullet runs, according to the Experiments of Merfennus, (quoted by Huygens in his Cofmotheoros, p. 125) 100 French Toifes of fix Foot, in the face of a Second; and according to the moft accurate Admeafurement of the French, the Diameter of the Earth amounts to $6,538,594$ of the faid Toifes or Fathoms,

Accordingly then a Cannon-Bullet would run the length of the Earth's Diameter in about 65,386 Seconds, that is, full 18 Hours; from whence it follows, that it would run in one Year, confifting of 365 Days, 486 of the like Diameters, and 40 thereof in a Month of 30 Days.

Now it appears above, that (Tab. XXII. Fig. 1, and 2.) the length between the Sun and Earth, or the Line A S, being fuppofed to be 10,000 Diameters (which is lefs than what is allowed by Meff. Huygens and la Hire) the Diftance of Venus from the Sun, or the Line S C, will amount to 7000 of the faid Diameters; and if now we take the Revolution CIR for a Circle, of which CS is the half Diameter, the whole one CR

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will be $\mathbf{r} 4000$ of the Earth's Diameters; and fup. pofing the Ratio of the whole Diameter to the Circumference of a Circle, according to what is known, As 113 To 355; the Circumference CIR of this Diameter C R, which Ventus finiflies in $7 \frac{1}{\frac{1}{2}}$ Months, will be 43,982 Diameters of the Eatth.

But it is found before, That a Bullet runs 300 of the like Diameters in $7 \frac{4}{2}$ Months, or in the Time of Venur's Revolution. Thas it appears, that the Velocity of Venms, with tefpect to that of a Cannon-Bullet is, As 43,982 To 300 or; that Venus moves 146 times fafter than the faid Bullet. After the like manner, and with very little Trouble too, we may compute, that fince $\mathcal{F} u$ piter's Diftance from the Sun, or the Semidiameter of its Way (fuppofing it likewife to be exaetly circular) amounts to \$ 1,000 Diameters of the Earth, and that the Time of its Revolution is 12 Years; it moves about 59 times, at leaft a good deal above 54 , fafter than a Cannon-Bullet, that fhall run in one Year 486 of the like Diameters, as has been fhewn above. We fuppofe here the Courfes of the Planets to be uniform, tho ${ }^{3}$ Aftronomers find that they move one while fafter and another flower ; but forafmuch as they perform their Revolutions in about the faid Time, this Calculation is fure enough.

SEct. LXIV. The Swiftress of one of Jupiter's Moons.

IF we now fuppofe with Mr. Caffini, (See the Cofmotheoros, p. 101) that the neareft of Gupiter's Moons is diftant from it $2 \xi$ Diameters of that Planet, and that its Revolution is petformied in one Day, eighteen Houts, twenty eight Minutes, and thirty fix Seconds; the whole Diameter of the faid Revolution, will be $j_{\overline{3}}^{2}$, and the Citcumference
cumference, fuppofing it to be exactly circular, will be $17 \frac{272}{339}$ Diameters of Fupiter.

Now one Diametcr of $\mathcal{F u p i t e r}$ is equal to 20 Diameters of the Earth; the Revolution therefore of this nearef Moon is 356 of the faid Diameters, and according to the fuppofed Time of the Revolution this runs in one Day in its Way about $\mathcal{F} u$ piter, 201 Diameters of the Earth; and Fupiter, according to its before-fuppofed Diftance and Time of its Revolution runs 73 Diameters in its Orbit about the Sun in the faid Space of a Day ; fo that this Moon runs in its Orbit about twice or thrice as faft as $\mathcal{F}$ upiter itfelf, and confequently a great deal above 100 times fafter than a Cannon-Bullet, tho' it be as big as the Earth itfelf: See Huygeñs's Cofmotheoros, p. 101.

Sect. LXV. The amazing Force that is requifite to move Jupiter.

Now if one would form an Idea of the amazing Greatnefs of that Power by which the faid Planet is moved, it having been proved before, that the Diameter of $\mathcal{F u p i t e r}$ is 20 times greater than that of the Earth, it follows that the former Planet is 8000 times bigger than the latter.

Now thofe who undertand Mechanicks know, that by multiplying the Mals of two Bodies; each of 'em by its own Velocity, the Proportion of the Powers that move them, may be learned from thence : Suppofing then that the Earth's Magnitude to be as an Unit, and the Velocity of the Cannon-Bullet to be likewife as an Unit, the Force that muft move the Earth with the fame Swiftnefs as a Cannon-Bullet is moved, muft ailo be as an Unit, becaufe an Unit multiplied by itfelf produces only an Unit.

And in this Comparifon the Globe of Fupiter muft

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muft be fuppofed as 8000 , and its Velocity as $54 ;$ becaufe it moves in its Orbit 54 times fwifter than a Bullet; which being multiplied with the other, gives 432,000 for the Force that moves Fupiter.

So that it is irrefragably proved hereby, that the Force which moves $\mathcal{F u p i t e r}$, and confequently the Strength of that Planet it felf is at leaft 432,000 times as great as that which is capable of caufing the Earth to move with the fame Velocity as a Bullet is difcharged from a Cannon.

We fuppofe here the Denfity of the Parts of which the Earth and 7 Fupiter are compofed to be equal ; tho' fome reckon that of the Earth to be greater than $\mathcal{F} u p i t e r$ 's ; yet this difference will not hinder the faid Number from remaining a great many thoufands of Times more ; but this is not the Place to make fo nice an Enquiry in.

## Sect. LXVI. Convictions from the Whole.

Now they that hitherro doubt whether there be a mighty Creator and Director of this Univerfe, let them fit down by themfelves, and ferioully confider, Firft, How thefe Planetary Globes, fo amazing in their Magnitudes, are whirl'd about the Sun with fo dreadful a Velocity, fo far furpaffing the almoft unconceivable Motion of a Cannon-Bullet.

Secondly, How other Planets, or Moons, each of which will hardly yield in Magnitude to the Earth, are carried with a yet greater Swiftnefs about the aforefaid Planets.

Thirdly, That neither the Motion of Fupiter in his Orbit, nor of the reft of the Planets, can be performed but by a Force fo many thoufand times greater than that mighty Strength by which a Globe as large as the whole Earth is driven with the fame Velocity as a Bullet fhot out of a Caunon.

And if this laft Force, whereby the Earth can be fo fwiftly moved, furpaffes ali human Conception, what fhall we fay of that which moves the Planet $\mathcal{F}$ upiter in the Heavens?

## Sect. LXVII. The Evafions of Atheifts, and their. Pretences.

I K now very well, that in order to elude the Proof of an All-ruling God, which is fo terrible to Atheifts, thofe miferable Wretches are wont to conceive the Motions of the fe vaft heavenly Globes, as they were fo many round little Balls, floating and circulating in a Veffel of Water, which happens when the Water is put into a Circular Motion; and they are not a little confirmed in fuch Fancies; by the Figures with which Aftronomers are ufed to reprefent the Structure of the World, as may be feen in Tab. XXII. Fig. 1, and 2, where we find the Revolutions of the Planets reprefented like the forementioned Balls in Water, upon one and the fame Piane ; infomuch that there does not feem to be wanting any other Direction for their Motions than only conceiving a circular Motion of the Matter in which they fwim, and the rather, becaufe if one moves the Water in a round Veffel fwiftly about with a Stick, we may often obferve fome of the little Particles thereof whiring about their own Axis, and at the fame time carried about the common Center ; from whence they infer, That the Moons alfo of Saturn and Fupiter may be likewife carried about their refpective Planets, as here at F and H , without any particular Direction.

And thus thefe deplorable Difputers are ufed to contemplate, and to account for the Wonderg produced in the Heavens, without confidering

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the z \} Refemblances; and to make their Opinions pafs with greater Appearance of Truth, they ufe thofe fhallow Maxims of fome Philofophers, That the moft fimple Hypothefis or Notions that People form of things, are always the trueft, which being eafily agreed to by the Ignorant, and thofe who endeavour to evade the Labour of a juft Inquiry, fatisfies them the better, and procures them the more Difciples.

But in cafe things happen'd after fuch a manner, yet from the Motion of this Matter that runs round, (if there be any fuch Matter) an over-ruling Power of the great Director may bc) clearly enough demonftrated; fince Experience teaches (as flall be more fully proved by and by) that all fimple Motions are perform'd in Right Lines, and that Bodies can by no means defcribe Circular ones without fome particular Direction.

Sect. LXVIII. T'hofe Evafons anfwer'd; Firft, By the Orbs in which the Planets move.

But now when we turn away from this fictitious Heaven, which has no other Foundation but in the Fancy of thofe who only make ufe of it, that they may more conveniently (or according to them, more fimply) form an Hypothefis for the Appearances that are moft obvious to them ; and if we further apply our Contemplations, without any Prejudices, to thofe things which the true Inquirers have difcover'd by their Obfervations, about the Motions of the Planets, it may be concluded, and not obfcurely, by every one, that the former Evafions are groundlefs: For, Firf, All thefe great Globes are far from being moved in one and the fame Plane, as they are truly reprefented in Tab. XXII. Fig. r, and
and 2. tho' it be according to the common Manner, even of the greateft Aftronomers ; and we find that all of them cut thro' their Planes, the one the others, like two Hoops placed obliquely in each other. For inftance, let the Plane of the Paper upon which is drawn the third Figure in Tab. XXII. be the Plane in which the Sun revolves about the Earth (or the Earth about the Sun, for we do not difpute that Matter here) and let the Oval Figure EAF B, be in this fame Plane; then let us farther fuppofe, that the fecond Oval A C B D to be fo placed, that the Part ACB be above, and the other part ADC under the Plane of the firft Circle; fo that thefe two Planes, like the two abovefaid Hoops, have nothing common to each other, but one only Right Line A S B. If then we take this laft ACBD, for the Way of any Planet, we fhall perceive how it differs from the Plane of the Ecliptick, that is, from the Sun's or Earth's Way, and makes an Obliquity upon the fame, fo that there remains, between both the Planes, a Width, or Breadth, on the one Side as C F, and on the other of D E.

## Sect. LXIX. The Properties thereof.

Now to form a fuller and truer Notion of the Planets Orbits, we muft lay down fome Cons clufions which are known and agreed to by all Aftronomers, namely, That,

Firf, The Way or Orbit of each Planet is in a particular Plane, and peculiar to itfelf, fo that at one Time it is at C above, and another Time at $D$, under the Plane AEFB of the Ecliptick.

Secondly, That even the Moons of Saturn and Fupiter don't move in the fame Plane in the which the Orbit of their Planet, or likewife the Ecliptick lies; but that they decline from both, and according to the moft accurate Obfervation, compleat their Courfe in a particular Plane. See Whifonts Pralect. Aftron. p. 201. where he reckons up their Appearances.

Thirdly, That each of thefe particular Planes, in which the Planets move, do never interfect the Plane of the Sun's Way in the fame, but all in different Lines: So that, for inftance, if Mars does it in the Line A B, Jupiter will do it in the Line RT, Ơc. See Whifon's Pralect. Aftron.
p. 191.

Fourtbly, That even the Obliquities or Angles which the Planes of the Planets Orbits make with the Ecliptick, do not agree in any two fo as to be the fame, but are different in all of them : They who defire to know the Occafion and Meafure of thefe feveral Interfections and Obliquities of the Planes, (called by the Aftronomers Linea Nodorum ( $\sigma$ Inclinationes) fuch as A B, TR, and C F, E D, may meet with 'em, in the Automaton. of Mr. Huygens, p. 447. and elfewhere.

Fifthly and Lafty, We are to know, That all thefe interfecting Lines A B, T R, ©゚c. tho' they all of 'em differ, yet each of 'em pafs through the Sun $S$; fo that that Luminary fhines upon the Interfections of all the Planes of the Planets Ways.

Sect. LXX. The Atheifs Evafions Anfwer'd; Secondly, By the Planets continual Approach to the Sun.

Now if what has been already faid, concerning the wife and wonderful Direction of the Planets Motion, be not fufficient to convince the moft obdurate Atheif, a gracious God has been fureher pleafed to reprefent and manifeft to the Sight of every one, fomething in the Courfe of thefe heavenly Bodies that feems to put beyond all Difpute the Greatnefs of that Power which rules and directs them, and to reduce the Matter to an entire Degree of Certainty. In order to prove this, we affirm, and no body can deny it, that it is experimentally true, That all Bodies, when put into Motion, do proceed in a Right Line, unlefs fome other Caufe or Power obliges them to recede from it ; and it is known, that a Stone A moved circularly in a Sling about a Point S (Tab. XXII. Fig. 4.) in the Circle A H DE, with fuch a Swiftnefs, that it cannot be brought down by the Force of its Gravity when it is at A , will not continue to move in the fame Circle towards H , as foon as the faid Sling is loofe, and the Stone left to it felf, but purfue its Way according to the Right Line A F, which touches the Circle at A; and this happens not only in a Circle, but in all other Curve Lines, as Experience teaches us.

Now let the beft Philofopher tell us, how it comes to pafs, that fuch great Bodies as thefe Planets are, moving about the Sun with a Swiftnefs fo much greater than that of a Cannon-Bu!et, and with fo prodigious a Force as has been Thewn above, do not likewife obey this Law and un always in a ftrait Line, but defcribe inceffantly

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a Curve Line, and always return to the Point from whence they began; and how thefe moved Bodies are compelled every Minute to depart from their Right Line, and defcribe by their Courfe the Orbit which they do.

For that the Planet A (Tab. XXII. Fig. 5.) being moved about the Sun in the Curve Line A E D Z, when it is at A endeavours to go to F, according to the Tangent A.P, and when at G tends to I, along another Tangent GQ, as is difputed by no body. Tell us then the Reafon why fuch a great and fwift Globe, certainly tending from $A$ to $F$ and from $G$ to $I$, is continually protruded or attracted to the Sun, or at leaft is brought nearer to it ; fo that A F and G I, being the Lengths which the faid Planet is to run at each Place, in the following Minute, in the Tangent Lines AP and GQ, it is forced to forfake them, and, in the very fame Inftant, to approach fo much nearer to the Sun, as the Lines F G and IH are in Length; without which it would not be poffible that this Planet could continue in its Curve Way A ED C about the Sun ?

This is not to be anfwer'd by the Hypothefis which fome Philofophers have hitherto maintaind, That the Sun has a Vortex of a fubtile Matter about it, which running round, drags the Bodies of thefe Planets along its Stream; forafmuch as the Gravity thereof remains the fame; therefore they are bound to fhew why that Matter it felf defcribes a Curve Line, and does not, like other things, move directly according to Tangents; fo that here likewife we muft have recourfe to a Power that governs the Motion of this Marter ; but the famous Mathemarician Sir Ifanc Nerwton, and others, have fhewn, that we feek in vain the Properties of this Circular Motion in the Matter of the Vortices.

Sect. LXXI. Thirdly, By the Courfe of the Planets in an Ellipffs.

But to cut off all Cavilling about this Difference, it may be fufficiently proved from the Property of the Curve Lines, according to which each of thefe Planets are moved, that there mult be an inceflantly directing Power that regulates their Courfes, and that they cannot alone be carried forwards by any circularly moving Matter.

For the continual Experience of all Aftronomers that have fucceeded the Great Kepler, and fo frequently repeated Obfervations, have put it fufficiently out of all doubt, that the Planets are not moved in exact Circular Figures; in which Cafe it might be fuppofed, with fome appearance of Truth, that there is fuch a whirling Matter, but they are Curve Lines of quite another Property than Circles, and appear by manifold Obfervations to be Ellipfes, or oval Figures, as you fee in Tab. XXII. Fig. 5. A E D Z.

In thefe Ellipes, as is well known to the Mathematicians, there are two Points K and S , each of which they call a Focus, or Point of Burning, from whence the fame may be defcribed by a String KES, faften'd at K and S, and by a Nail at E, which being directed by the String, defcribes the Circumference ED Z A, as is known to Carpenters, Joiners, and other Mechanicks.

In one of thefe Foci is p!ac'd the Sun S, about which the Planet is continually moving; $A$ is the remotef, and $D$ the neareft Point of the Orbit to the Sun; for which Reafon likewife, A the fartheft, and D the neareft Point to the Sun, are termcd by Aftronomers, the Apberlium and Perbelium.

Sect. IXXII. Fourthly, Becaufe their remoteft Points extend to different Parts of the Heavens.

AND that no body may imagine neither, that any ignorant Laws of Nature have any Place here in a Stream of Vortices, or whirling Matter ; the adorable Creator, who alone will be acknowledged and glorified herein, has fhewn, with irrefragable Proofs, his abfolute Empire over thefe great Bodies, and likewife his wonderful Power in thofe vaft and remote Spaces; for which Purpofe he has not thought fit that the Elliptical Orbits of the Planets, as A E D Z, and L R, M T, (which very much differ in Magnitude and Difance from the Sun) fhould have theic Apbelia A and Lextended from the Sun S to one and the fame Place of the Heavens, as B; which would have appeared more convenient to our Conceptions, and might have been ufed as a Principle to difcover, after this manner, a general Law of Nature, whereby we could have accounted for thefe Motions and Difpofitions in the Heavens.

But to the End that every one who contemplates thefe great Works might be certain, on the contrary, that it is only the irrefiftable Will of a fupream Director of all things that has place in this Matter, he has fo order'd the Orbits of the Planets A and $Y$, namely, AEDZ and YVNW, for fo many Ages, that the one feems to be entirely independant of the other; placing not only each of them in a different Plane obliquely lipon the other, as we have fhewn above, but likewife caufing ail the Lines proceeding from the Sun S , thro? the Aphelia or remoteft Points $A$ and $Y$, to tend to different Parts of the Heavens, as $B$ and $C$ altho? the faid Sun $B_{?}$
with refpect to which only he has made them, does fufficiently appear in the one Focus of all thefe Ellipfes: The Truth of this may be feen in all the Books of the Aftronomers, and particularly the Places of the Aphelia of each in the Automaton. of Mr. Huygens, p. 441.

## SECT. LXXIII. Convictions from thence.

Now after having well conceived all this, thofe who think it concerns them to learn God from his wonderful Works will be pleafed to ufe their Endeavours, firf, by what has been faid, to make a true Notion of the Planetary Heavens familiar to them, and comparing one thing with another, to confider whether a Man argues without Foundation, who maintains, that the Power and Wifdom of the Great Creator flines out more brightly here than the Skill and Contrivance of the Workman in the moft curious Clock, or any other Machine whatfoever.

For, Fir $f$, confidering the almof unconceivable Magnitude of thefe wandering Globes, and their Diftances from the Sun, which may only and eafily be determined by the Diameters of the Earth. And, Secondly, feeing that Saturn, tho ${ }^{2}$ it be diftant from the Sun at leaft 100,000 of the faid Diameters, according to the lateft Obfervations, between every two following Points of its Orbit, is always attracted towards the Sun, notwithItanding there is not the leaft Band or Connexion between the one Body and the other. Thirdly, Finding that thefe Approaches to the Sun have place in all the Planets, tho' there is likewife no Union between any of them. Fourtbly, Knowing that each of 'em performs its Courfe in a particular Plane. Fifthly, That they defcribe no Circies which we fee generated in natural Motions, particular Direction obtains here, they move in Ellipes, or oval Figures, every whery preferving their Geometrical Properties. Sixtbly, That thefe oval Figures are each of "em extended lengthwife to a different Place in the ftarry Heavens. Seventhly, That their Motions have continued for many Ages in this Order, without any Confufion among each other. And, Finally, fince no body, who underftands it right, can, without Amazement, obferve, That thefe Globes of fuch an amazing Magnitude (that Fupiter is at leaft 8000 times bigger than the Earth, and the reft, excepting Mercury and Mars, which are fomewhat fmaller) are either as big, or bigger, than the Earth itfelf, and yet all of 'em move about the Sun with fo prodigious a Swiftnefs, as far exceeds that of a Cannon-Bullet.

Secr. LXXIV. The Motion of the Planets about the Sun.

Now if we reflect upon the Experiments which, befides the foregoing, have been made by the modern Aftronomers, and would be too tedious to be related here, new Wonders would occur to us at every Turn, and always adminifter frefh Occafion of acknowledging a tremendous Power, and a Direction continually exerting itfelf.

To fay nothing therefore of the Comets, and their Courfes from and to fo many different Places of this immenfurable Space, fince neither their Caufes, nor the Ends for which they have been made, do yet fully appear to us : Let us once again bring before our Imagination thofe great Celeftial Globes, the Planets, and confider, that in that incomprehenfible Motion with which they circulate about the Sun in their Orbits, they likewife
likewife revolve or turn upon their own Axes from Weft to Eaft, at leaft it has been vifibly obferved already in Fupiter, Mars and Venus, and even in the Sun itfelf.

Thus we find (to fay nothing of the Earth, fince all Aftronomers do not agree therein) that that dreadful Globe of Fire, the Sun, turns round upon its own Axis in 25 Days; Venus in 23; Mars in $24^{\frac{2}{3}}$; and the great Globe of Jupiter in 10 Hours. See Gregory's Aftronom. p. 36. As for the reft, we have not yet been able to difcover any thing certain about them.

And in order to convince every one of the Dreadfulnefs of the Powers which exert themfelves in this Matter, we need only invefligate the Swiftnefs wherewith thefe great Globes are carried about their refpective Axes after the following fimple Manner.

For fuppofing the Earth's Diameter to be 6,538,594 French Toifes or Fathoms long, the Circumference thereof will contain $23,541,600$ of the fame, fince the Diameter of a Circle Is to its Circumference, As 7 To 22, or yet nearer, As 113 To 355.

Now each Point that is upon the middle Superficies of the Earth would run fo many Fathoms in 24 Hours, and confequently $237^{\frac{5}{4}}$ in one Second of an Hour.

But a Cannon-Bullet (as has been fhewn above) runs 100 of the like Fathoms in a Second.

Confequently every Point upon the Equator of the Earth revolves with much more than twice the Swiftnefs of a Cannon-Bullet.

If then, according to this Proportion, the Velocity in the Revolutions of the other Planets be meafured, and if it be fuppofed (to fpeak within compafs) that the Diameter, and for the fame Rearon the Circumference of the Sun, is but

So likewife $\mathcal{F} u$ piter, which is 20 times as big as the Earth, and revolves in the fpace of ten Hours, would carry every Point in its Equator 20 times as faft about its Axis as thofe of the Earth; fuppofing that this Planet fhould likewife require 24 Hours for that Purpofe; but as it performs the fame in 10 Hours, its Velocity will be yet $2 \frac{2}{5}$ times greater, or Jupiter will revolve 48 times fwifter than the Earth, and each of the aforefaid Points move above roo times fafter than a Cannon-Bullet.

Sect. LXXV. The Velocity of Saturn, and of his Ring.

Let us moreover caft our Eyes upon Tab. XXIII. Fig. 2. or the Reprefentation of Saturn A, and its Ring GI, and confider, that this Globe H is about 2000 times bigger than the Earth, and that the Ring G I is full 4 times as broad as the Globe of the Earth is thick, and that the Space likewife between the faid Ring and the Body of that Planet is not lefs in its Breadth. Again, that this Ring is thin and flat, and no way adheres to Saturn, but is quite loofe round about, as has been hinted above; yet that this Ring never forfakes nor ftays behind Saturn in its Motion, but always accompanies it with equal Velocity, and has done fo for many thoufand Years, notwithftanding that that Globe moves about 20 times as faft as a Cannon-Bullet, as may be eafily computed after the abovemention'd Manne:.

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## CONTEMPLATION XXV.

Of the Unfpeakable Number, and Unconceivable Smallnefs of the Particles of which the UNIVERSE confifts.

Sect. I. Tranfition to the Smallnefs of Parts.
F now, after having Contemplated the vifible
World in fome of its Parts, we turn our Thoughts farther, to thofe fo wonderfully fmall and numerous Particles of which the former confifts; and then confider the Laws which they continually obey, tho' ignorant of the whole, and even of themfelves too; and which Laws the Great Creator has been pleafed to render fubfervient to the Execution of his marvellous Purpofes, that Man mult be quite blind and inexcufable, that cannot difcover therein, the Power, Wifdom. and Goodnefs of an adorable Ruler of the Univerfe.

The Reader muft not expect to meet here with an exact Defcription of the Figures thereof, forafmuch as without ever being thoroughly fathom ${ }^{3}$ d. or comprehended, they will always furnifh new Matter of Inquiry to learned Men, as long as this Univerfe fhall be preferved in its prefent State and Condition. We fhali therefore only confider fome Matters and Bodies with refpect to their Smallnefs, not perhaps fo thoroughly as the accurate Truth

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of the Thing may require, but only fo far as Experience may lead us therein.

Sect. II. All Bodies confift of Small Parts.
Now that all vifible Bodies do confift of an unconceivabie Number of fuch little Parts, is already admitted by all Philofophers, and demonfrated too by fo many Experiments and Proofs, that no Body who has taken the leaft trouble of examining the Nature of Creatures, can entertain any kind of doubt thereof. Concerning which, Robault's Phyjecs, Boyle's Subtil. Effuvia, Keill's In ${ }^{\star}$. troduction, and other Books may be confulted.

## Sect. III. Our Conceptions muft be Rectified.

But as our Imagination is uncapable to reprefent to us the amazing Magnitudes of the Heavenly Bodies, fo likewife we find it as little able to give us juft Ideas of the Smallnefs of the Parts whereof all vifible Things are compofed; for which Reafon as the former, fo likewife the latrer is by many thought Incredible, efpecially by fome of thofe, who, when they conceive Things according to Truth are afraid they fhall difcover in them a great and terrible God.

> Sect. IV. A Cubical Inch contains a Million of vijible Particles.

All kind of vifible Bodies may be divided into Fluid and Solid; we will begin with the Firf:

And before-hand advance what Mr. Boyle in the beginning of the fecond Chapter de Subtil. Effuv. affirms to appear by Experience; namely, that the Length of an Half-Inch, can be divided
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into Ioo Parts, which fhall all of 'em be big enough to diftinguifh themfelves for Ufe; but we, to prevent all Cavilling, will only maintain the fame of an entire Rynland-Inch; from whence it follows, that a Cubical Inch, or a fquare Stone, which is an Inch long on all Sides, contains a Million of fuch little Cubes, each of which in all their Dimenfions, or in their Length, Breadth and Thicknefs, are no more than the $\frac{\bar{T} \frac{\tau}{\bar{\circ}} \mathrm{O}}{0}$ of an Inch long, which is known to every one that is a little verfed in the Principles of Geometry.

So that we may fafely lay it down for a Truth, fince if the Length of fuch a fmall Cube is vifible, the whole little Cube will be much more vifible, That a Cubical Inch contains a Million of vifible Parts.

Sect. V. A Cubical Inch of Water contains the like Number of Parts.
Now if the Point of a Needle can be ground fo fharp, that the Breadth of it may be equal to the Breadth of fuch a fmall vifible Particle; and that this Point were to be juft dipt in Water, and being drawn out again, fhould appear wet, or that fome Water cleave to it, all which may be allowed without any Difficulcy: If then it fhould be farther fuppofed, that there was but one only Particic of Water that fuck to it, and (for the more convenient Computation) that it was as thick as the little Superficies of the Point of the faid Needle; and moreover, of a Cubical Figure, it is plain from the Premifes, that it is no bigger than $\frac{x}{x .000,000}$ Part of a Cubical Inch of Water, and confequently that fuch an Inch contains a Milliour of Water-Particles, which if they were feparated, would each of 'em be fo big as to be vifible From whence it follows, that fuch a valt
846. Tbe Religious Pbilofopber. quantity of Cubical Inches of Water as are in the Univerfe, in Air, Earth and Water, and are moved, muft certainly contain fo many Millions of Parts, and be as certainly moved.

Sect. VI. A Cubical Inch of Water Ravified in an Eolipile, will yield above 13300 Millions. of Parts.

But to proceed a little farther; Mr. Boyle, in the Third Book of the above-mentioned Treatife, fays, that (See Tab. XXIII. Fig. 3.) an Ounce of Water E F G, being put into a Copper Globe A, in which there was a little Hole at B; the faid Globe commonly called by the Learned an Eolipile, was put upon the Fire ; whereupon the Vapours of the Water begun to be protruded thro ${ }^{9}$ the faid little Hole B, which produced a Pyramid of Vapours D BC, for the Space of 18 or 20 Minutes; the Length of which BR, was twenty Inches, and the greateft Breadth at $C D$; was of one Inch: Yet fo, that at the Diftance B M, (being five or fix Inches farther than B R) they could perceive vapoury Clouds ftill hanging together, which extended themfelves to the Breadth of four or five Inches at K L.

If now for the more ealy Reckoning, we confider the long Pyramid B D C, joyned to the fhort one DCK L, as one only Pyramid; the Length of which from $B$ to $R$, is of 21 Inches, and the Diameter from C to D of $x^{\frac{2}{2}}$ Inch, the Superfices of the Circle C N D G will be $\frac{99}{5}$ Superficial Inches, which Multiplied by 7, (being the ${ }_{\frac{\pi}{3}}^{3}$ of BR or ${ }_{21}$ ) will amount to the Magnitude of $\frac{99}{8}$, or $12 \frac{3}{3}$ Cubical Inches for the whole Va-pour-Pyramid.

If this had been computed nicely according to Mr. Boyle's Meafure, the long Vapous-Pyramid

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BCD, together with the fhort Cioud-Pyramid CDLK, would amount to above 32 Cubical Inches, tho' we. fhould reckon BR to be but 18 , $\mathrm{CD}_{\mathrm{r}}, \mathrm{RM}_{5}$, and $\mathrm{K}_{4}$ Inches; but for the greater Convition, and to prevent all Cavilling, we have reckoned it all to be but 13 Inches.
Let us now fuppofe, that one of the Particles of the Vapours rufhing out of the aforefaid Eolipile, runs the Length from B to R in the Second of a Minute ; fo that in every Second there is a new Vapour-Pyramid formed: There would then in 18 Minutes, or in 180 Seconds, fo many different Pyramids have come out.

Now each Vapour-Pyramid makes ${ }^{12}{ }_{8}^{7}$ Cubical Inches, and confequently all fach Pyramids as are formed from one Ounce of Water, will produce $12 \frac{2}{8}$ times 1030 , or 13,365 of the like Inches. If now in each vifible Particle of all thefe Pyramids there is but one Particle of Water (fince there are a Million of 'em in one Inch) there will be in the whole $13,365,000,000$, and confequently one Ounce of Water may be really divided into 13,365 Millions of Parts at leaft.

But fince it is defired to know farther, into how many Parts an Inch of Water may be likewife divided after the faid manner; let us fuppofe, that a Cubic Foot of Water weighs 64 Pounds, and that there are ro Inches to a Foot; accordingly a-folid Foot will contain 1000 of fuch Inches, and at the rate of 16 Ounces to a Pound, there will be 1024 Ounces in 64 Pounds. From whence it is eafie to prove, that a Weight of one Ounce makes $\frac{7000}{1024}$ or $\frac{250}{255}$ of (or rather almoft) an Inch; fo that we may fafely enough affirm, that a Cu bical Inch of Water is according to this way divifible into 13,000 Millions of Parts.
$\mathrm{S}_{\mathrm{ECT}}$. VII. There may hang above 13,000 Particles of Water to the /harp Point of a Needle.

Now it appears from Section the sth, that the Water which may ftick to the extream Point of a Needie, which is fo tharp, as to be juft vifible, and the Breadth of which is $\frac{x}{500}$ part of an Inch, may fafely be allowed to amount to the thoufand thoufandth part of an Inch.

Therefore it is fufficiently certain, that this little Water that fticks to fuch a fine Point does confift of not lefs than 13,000 Particles, if it be only a little Cube of Water that has the fame Breadth.

## Sect. VIII. That a Drop of Water is divifible into above 26,000,000 Parts.

But now let us compute with Amazement, how many Parts are to be found in one Drop of Water, upon the Suppofition which has been juft now proved, that as oft as one dips the Point of a Needle or fine Pin, and fomething adheres thereto, fo often there are 13,000 Particles of Water requifite to compofe the faid Drop.

Now to form a rough Conception of this Matter from another Method; let a Drop of Water be fuppofed to be of the Weight of a Grain, of which 480 go to an Ounce Troy-Weight, and compute according to the Rule of Three, that if 480 Grains gives $\frac{250}{250}$ Parts of an Inch, what gives one Grain ; and we fhall find it to be full $\frac{1}{49^{x}}$ Part of an Inch.

Now to lofe nothing, and to allow enough; let us make the Calculation with a fmaller part of an Inch, namely, with the $\frac{x}{500}$ thereof; and fup-
pofe that a Drop, tho' it be greater, does not contain more Water-Particles.

Now a Cubical Inch of Water contains 13,000 Millions, or a Million of times 13,000 Particles, confequently $\frac{1}{500}$ of an Inch, or one Drop, contains 2000 times 13,000 Water-Particles, or in one Sum $26.000,000$, that is, fix and twenty Millions thereof; of which if we again caft away fix Millions, becaufe we don't defire to have too much granted to us, it feems plain beyond Contradiction, that in one Drop of Water no bigger than $\frac{x}{500}$ of an Inch, there are at leaft not fewer than twenty Millions of Water-Particles.

Sect. IX. Convitions from the foregoing.
Before we proceed any farther, let an Atheift fop a little here, and confider with us, how great and how penetrating that Providence and Direction mult be, which before a Drop of Rain-Water of the Quantity and Weight only of one Grain fhall fall down upon the Earth, has thought fit to compound it of fo many Millions of Parts.

And if he fhould refure, as he has hithertodone; to own a Providence herein, let him tell us, whether he can perfwade himfelf, that fuch an innumerable Multitude of Millions of Wa-ter-Particles could by meer Chance, or without any Wifdom and Direction for fo many thoufands of Years continually and incefliantly proceed from Seas, Rivers, and other moift Places, rife up into the Air, divide themfelves into Clouds, as it were into fo many Armies; where floating in that thin Matter, they are carried by the Winds towards fo many different Parts, in order to compofe whole Streams and Rivers; to defcend in Rains upon the dry Ground; to caufe the Fruits of the Earth to grow ; to furnifh Drink to. all can never fufficiently praife that moft adorable Wifdom that has feparated, and as we may fay, rent all thefe Particles, and render'd each of 'em, how little foever they be, loofe and free from the reft ; without which Divifion they could not have afcended by reafon of their Weight, nor hardly been of any Ufe. And Lafly, That he is bound to return Thanks to this fo gracious Benefactor, who has made fuch an unfpeakable Number of Beings fubfervient to his, and all other Mens Advantages, after fo multifarious a manner.

Sect. X, XI, and XII. This Hypothefis founded upon the Obfervations of Mr. Leuwenhoek, namely, That a Drop of Water contains many more than one Million Millions of Parts; the fame applicable to all kinds of Liquids.

THave been willing to prove here by degrees, that the Particles of Water are exceeding fmall, to the end, that I might not at firft deter our Imagination from Contemplating the fame, by reafon of fuch a Smallnefs, of which it can fcarce poffibly frame any Idea to itfelf; and therefore the Reader will be pleafed to judge from what follows, whether he muft not agree, that altho' the now computed Smallinefs does feem already to
efcape our Imagination, yet that it is far different from that which we muft neceffarily allow to be found in the Particles of Water.

Now to fhew this, we will lay down for a Foundation, the Experiments of Mr. Leuwenhoek, as they are defcribed by him in his Letter of the 12th of Nov. 1680, p. 29 ; where he relates, that he diftinguifhed in Pepper-Water, in the Sperm of Animals, \&cc. three forts of Animalcula of different Sizes, of which if we take the Diameter of the fmalleft for the Meafure of the others, and call it an Unit, that of the Second or next biggeft Animalculum or Infect will be 10, and that of the Third or biggeft rootimes as long as the Diameter of the Second; fo that the Diameter of this laft, is $1 \times 10 \times 100$, or 1000 times as long as that of the Firft.

If now for the more convenient Calculation, this laft Animalculum and a Grain of Sand be fuppofed to be of the fame Figure, for Inftance, that each of 'em be either Globular or Cubical, the Grain of Sand will be fo much bigger than the Body of this Animalculum as the Cube 1,000.000,000, of the Diameter 1000 of the laft is bigger than the Cube I of the Diameter I of the firf, and confequently we fee that fuch a Grain of Sand is equal to 1000 Millions of thefe Animalcula, each of which are vifible thro a Microfoope.

Now Mr. Leurwenhoek (in his Difcoveries the 26 th of April 1679, p. 14.) fuppofes that 100 Grains of Sand are equal to an Inch in Length ; fo that $1.000,000$ of fuch Grains compofe a Cubical Inch.

If then we argue after this manner :
Since r,000.000,000 Animalcula go to one Grain of Sand, and $1.000,000$ Grains of Sand to ans Inch, which we here reckon at $\frac{x}{\frac{x}{3} 3}$, and not $\frac{x}{82}$ part of a Foot) there will be contained in fuch a Fff 3

Cubical

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Cubical Inch, $1.000 .000,000.000,000$ of thofe Animalcula.

But according to Sect. VIII. it appears, that one Drop of Water is $\frac{ \pm}{s o o}$ of an Inch ; fo then according to that Calculation, $2.000,000.000,000$ Animalcula are but equal to fuch a Drop of Water.

But to prevent any Objetions againft the faid Calculation, we will abate the half of it, according to which there will be then a thoufand times a thouffand Millions of thefe Animalcula capable of being contained in one Diop of Water.

This laft being now proved about Water, we may eafily fee that it is applicable to many other fluid Matters, efpecially to fuch as are wet, and which by fticking to folid Bodies do moiften the fame; for which reafon we need not fay any thing of Oil, Spirits and the like ; but we will add a few words about other Fluids that are not moift.

Sect. XIII, XIV, and XV. The Smallnefs of the Particles of Air, Fire and Light.

The abovemention'd Mr. Leuwerhoek in his 7 th Continuation, p. 424, fays, that having preffed the Air and Blood out of the little piece of the Lungs of a Sheep, he found that many of the Air-bubbles were fo fmall, that they were hardly vifible even with a Microfcope, infomuch that they muft be fmaller therefore than thofe Animalcula which we have lately fpoken of from him, and which could be feen : And confequently a Grain of Sand is more than equal to $\mathbf{1}, 000$ Millions of the fame, or a Cubical Inch will contain above 1,000.000,000.000,000 Farticles of Air.

Now tho' fome think they have reafon to believe, that the Particles of Air are bigger than thofe

thofe of Water, becaufe the latter can pafs thro' Orifices or Holes, which feem impervious to Air; yet we fee that the Particles of this latter are excecding fmall, fince it might be demonftrated here, That by reafon of their Invifibility they far furpafs in Smallnefs the aforemention'd Animalcula.
Certainly that they do likewife penetrate thro' very narrow Paffages, is not only plain from Plants, into all which they infinuate themfelves, tho' we cannot difcover any Pores or Cavities in fome of 'em ; but it is likewife well known to thofe that handle Air-Pumps, who find how much Pains it cofts them before they can exhauft the Air; at leaft if it may be proved, as perhaps it can, that tha Particles of Water are fmaller than thofe of Air ; this is ftill fufficient to convince us particularly, that we are far from having as yet inveftigated the real Smallnefs of the Particles of Water.
Now how much more minute Parts, Fire confirts of, than all thefe above-mention'd Fluids, may appear from hence, that Air, Water, Oyl , and the like, are found to confift of fuch grofs Parts, that they cannot pafs thro' the Pores of Glafs and other hard Bodies as Iron, Steel, ofoc. and can therefore be excluded or kept out from Veffels made of thofe Materials; whereas there are no Paffages, tho' ever fo fmall, in any Bodies thro' which the Particles of Fire cannot penetrate; which appears by their rendring all Bodies either glowing, that is to fay, full of FireParticles, or putting them into Fufion, or caufing them to evaporate; of all which nothing could come to pafs, if the Fire were not able to infinuate itfelf into the innermof Parts of thofe Bodies.

We fhould now pafs on from the Fire in the laft Place, to its Effluvia or Matter of Light, and give the Reader here a rough Sketch of the Finenefs of the Parts thereof, fince we are far from being able to trace the Multitude and Smallners of them, and particularly have given a certain Demonftration how many Particles of Light may be fafely affirmed to fly out of a burning Candle in the Second of a Minute.

They that have not a mind to tead the following Demonfration, may pars on to Sect. XVI, and XVII.

A Calculation of the Number and Smallinefs of the Particles of Light.
I. It is fuppofed, That the Flame of a Candle of Six to the Pound, may be feen at the Diftance of 2000 Paces, or 10,000 Foot, each Pace being computed at 5 Foot; that is, from O to E. Tab. XXIV. Fig. i.
II. It is plain then, Since the faid Flame may be feen at the fame Diftance all round, that it fills the whole Globe or Circle R QES.
III. Now to find the Bignefs of this Globe R E, we muft firf obferve, that the whole Diameter is equal to twice O E, that is, 20,000 Foot.

And forafmuch as 100 Is to 314 As the Diameter R E To the Circumference R QES, we Shall find, by the Rule of Three, that this Circumference includes 62,800 Feet.
IV. Now if we muitiply the whole Diameter by the Circumference, and that Product by the fixth Part of the Diameter, it will produce the folid Contents of the Globe R QES, being $41.866,000.000,000$ Cubical Feet, as is know to all Geometricians:

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V. If now we divide a Foot into ten Parts, and call each of 'em an Inch, I Cubical Foot will contain 1000 Cubical Inches; as the aforemention'd Globe will contain $41,866.000,000.000,000$ Cubical Inches, which for Shortnefs, and that we be not every time obliged to write the faid Sum at length, we will exprefs by placing the Number of the Cyphers omitted over the firt Cypher : So that according thereto, fuch a Globe contains $4^{1,8660^{\mathrm{TI}}}$ of fuch Inches.
VI. Again, Since a Candle of 6 to the Pound, will burn Five Hours, it may be eafily computed, how much thereof will be fpent in a Second; for allowing 3600 Seconds to one Hour, and to every Ounce (i6 of which make a Pound) 480 Grains, Apothecaries Weight, we fhall find by the faid Rule of Three, there is burnt in one Se-
 low.
VII. Now to know how many of thefe Grains of Tallow, or Wax, go to one Foot:

Let us fuppofe, Firf, That a Cubical Foot of Water weighs 64 Pounds, to which the Weight of mof Waters will amount.
And, Secondly, That 5 Feet of Water are as heavy as $5 \frac{1}{3}$ Cubical Feet of Wax. Vid. De Stair, Senguerdius, \&c.
Suppofing then Wax and Tallow to be of equal Weight, fince the Experiment of burning 5 Hours has been made with a Tallow-Candle, 5 Feet of Water will amount to 320 Pounds Weight, and fo will $5 \frac{1}{3}$ or ${ }^{\prime} \frac{6}{5}$ Feet of Wax or Tallow.
So then a Cubical Foot of Wax weighs 60 Pounds, that is, 460,800 Grains, and confequently I Grain the $\frac{x}{40080}$ Part of a Cubical Foot of sooo Inches, which being reduced to fingle Inches, amounts to $\frac{10}{4008}$ or $\frac{5}{485}$ of a Cubical Inch.
VIII. Now it we confider here likewife the aforemention'd Velocity of Light, and fuppofe OE the Diftance of the Candle O to the End of the enlighten'd Globe Q E R S, to be $x 0,000$ Feet; and whereas it has been already proved, that the Light of $7 u p i t e r$ 's Moons paffes thro ${ }^{\circ}$ the whole Space which is between the Surs and Earth, or 12,000 Diameters of the Earth, in the Part of an Hour, or 450 Seconds, that is, in one Second $26 \frac{2}{3}$ of the faid Diameters; it will follow then, that every one of thefe Diameters being computed at $39.231,564$ Paris Feet (See Whiforn. Prelect. Aftron. p. 13.) according to the moft accurate Admeafirement of the French, the faid Light will run $1,046.175,040$ of the faid Feet; fince fo many of 'em go to the faid $26^{2}$ Diameters of the Earth.

But in cafe any one fhould affirm, that this Calculation is too large, forarmuch as it fuppofes that the Light of a Candle runs as fwift as that of the Sun, he muft be pleafed to obferve, Fir $\ell$, That it has not been yet demonftrated, that one kind of Light moves fafter than another. For if a Man were placed in a great Dark Room, and a Hole were made in the fame, for the Day-Light to pars thro', or before which Hole a Candle were held, I don't think that the Light of the Sun would reach him fooner than that of a Candle, at the fame Diftance. But it is hardly poffible to make fuch an Experiment, becaufe the Difference between fuch great Velocities of both thefe Lights is not to be obferved. Secondly, Becaure Light does probably not vary its Swiftnefs at all ; fince the furprizing Emanation of Light, of which mention has been made before, and is now here repeated, is not obferv'd with refpect to thofe Ravs that proceed immediately from the S:n, but only as they be reflected from Fuppiter's Moons.

Moons. So that it retains fill this Velocity after having run above five times the Length of that Space between the Sun and Earth; for fo have we fhewn above, in Contemplation XXIV. that 7 upiter is at fuch a Diftance from the Sun. Thirdly, Befides, feveral other ways by which we might prove the unconceivable Velocity of the Particies that proceed from a burning Candle, the fame does appear by the Effects it has in melting Glafs, Enamels, Metals, and other very hard Bodies; which Force, fince it can't be afcribed to the Magnitude of the Particles, they being exceeding fmall, muft needs refult from their Velocity ; it being a known Rule in Mechanicks, that all the Force of Bodies is in Proportion to their Mafs multiply'd by their Velocity.

But that we may here likewife concede enough, let us fuppofe, That inftead of fo many more than 100,000 times, in which the Light would fill this Globe in one Second, it be only 1000 times, whereby the Motion of the faid Light is granted to be above 100 times flower, as it mult be, if we compare its Velocity with that of the Light which comes down to us from Jupiter's Moons.
IX. We fuppofe farther, that the fmallef Animalcula that can be render'd vifible by the beft Microfcope, is much bigger than any Particle of Light. Firf, Becaufe many more Particles of Light than one are requifite to render it vifible. Secondly, Becaufe thefe Animalcula are vifible, whereas the Particles of Light are invifible. Thirdly, Becaufe Light can pafs thro' the imperceptible Pores of Glafs, which the fmalleft Infect in the World can't do. And, Fourthly, This appears very plainly to fuch as know that thefe Animalcula being view'd againft the Sun with a good Microfcope, it is obferv'd not only that they are tranfparent, but alfo that the Colours of the Rainbow ; to produce which, many and different Rays are neceffary. The Pheroomenoin is familiar to thofe that deal in Microfcopes, and we find it confirm'd in the feventh Continuation of Leuwenhook, p. roo. We premife this, for the fake of what follows, namely, That an inexpreffible Number, or $10 \stackrel{20}{\circ}$ (a Unit with 20 Cyphers) of Light-Particles is really contain'd within the Space of one of there fo fmall Infects; as alfo to affift the Weakners of our Imagination.

X . It is likewife known, That when a burning Candle placed at O, (Tab. XXIV. Fig.I.) and diffufing its Light as far as $E$, and filling the whole Globe E Q R S, communicates the fame to the Point A, which is near the Candle, the faid Point A, will be as much more enlighten'd than another. Point E , which is at an equal, or greater Diftance from thence, as the Square of the greateft Diftance (for inftance, of OE ) is greater than the Square of the Small one OA.
In the Language of the Mathematicians, what we have laid down above, is exprefs'd in the following Manner :

The Number of the Farticles of Light in two equally great, but unequally diftant, Places from the Flame, are to each other in an inverted Ratio of the Squares of their Diftances. This has been fhown more circumftantially above in Contemplation XXIV. and is well known to all Mathematicians.
XI. To proceed a little farther :

Suppofe then that O E, or the utmof Extent of the Light in the illuminated Circle QRSE, be of the Length of $10,000.000,000$ or 10 응 of fuch Animalcula as Mr. Leuwenboek view'd with his Microfcope (why we reftrain it to juft this Number, flall be flowis hereafter in Num. XXIII.) and ler the Length of the Ray OE be divided allowing to each of them the Length of one of the faid Animalcula.

If now it be farther fuppofed, That in the Space of that Animalculum, which is the laft and moft remote from the Candle $O$, as here at $V E$, there be but one fingle Particle of Light ; and that the nearer there Points come to the Candle in every following Space, as D O, CB, BA and A $O$, the Light-Particles always and continually increafe in the Animalcula, according to the aforefaid Rule Num. X. It may be accordingly known, how many Particles of Light are contain'd in the Space of an Animalculum, the Diftance of which from the Candle O, is likewife known, as here at O A, AB, B C, ©゚c.
XII. For this Purpofe, and for the fake of Order and Conveniency, Let there be perpendicular Lines of an indefinite Length drawn upon the Points $\mathrm{A}, \mathrm{B}, \mathrm{C}, \mathrm{D}$, and all the Partitions of thefe Lengths of the Animalcula, fuch as A $g, \mathrm{~B} h$, $\mathrm{C} i, \mathrm{D} k, \mathrm{E} q, \nleftarrow c$. in order to defcribe thereby the Number of Light-Particles which are to be found in the Space of each particular Animalculum.

And having taken at Eq the Length EF, equal to an Unit, forafmuch as in the laft Space V E, there is fuppos'd to be contain'd but one fingle Particle of Light; and OE being found as above, to be equal to $10^{\frac{10}{}}$, fay, according to the foregoing Rule :
I. As the Square of $O A$, or I , Is to the Square O E, or $10^{10}$ : So is F E (a Light-Particle in VE) To $A a, 10^{20}$; or the Number of Light-Particles in O A.

Take then in the indefinite Line $A g$, the Length Aa equal to $10^{20}$, fo will this Line Aa reprefent the Number of the Particles of Light at $A$, or in the Animalculum's Space OA.
2. As
2. As 4, or the Square of OB, which coritains two Animacula, Is to the Square of OE, or $10^{20}$, which contains the Length of $10-10$ Animalcula : So is 1 or F E To $10_{\frac{20}{4}}^{4}$ or $250^{18} \mathrm{~B} b$.
3. So likewife when OD contains 10 Animalcula in Length, to find $\mathbf{D} d$, or the Light-Particles that are in D.

As 100, the Square of O D, $10=$ To $10^{10}$, the Square of OE So is 1 , or FE, To $10 \frac{20}{100}$ or $10^{2}$, or $\mathbf{D} d$, and fo of all the reft.
XIII. From hence then it appears, that if Perpendicular Lines, fuch as $\mathbf{A} a, \mathbf{B} b, \mathbf{C} c, \mathbf{D} d, \bigotimes_{c} c$. be let fall upon all the Partitions $\mathbf{A}, \mathrm{B}, \mathrm{C}, \mathrm{D}, \mathrm{O}_{\mathrm{c}}$. as the Line OE is divided into $10^{\circ}-$ Parts, and each of them amount to the Number of the LightParticles contain'd in the Spaces of the Animalcula O A , B C, AB, D D, ©̛c. there would be nothing requifite more than to add up the Numbers of all the faid Perpendicular Lines together, in order toknow how many Particles of Light are contain'd in all the Animalcula Spaces of O E, as they increafe after the faid manner from E to A , in which there is no Difficulty,
XIV. As likewife by drawing GF parallel to OE, fo that A G, Br, C $s, \mathbf{D} t, \dot{\delta} c$. be each of 'em equal to $F E$, or an Unit; that the Sum of all thofe Units will produce the Number of all the Light-Particles that are contain'd in O E; if in each Animalcula's Space, O A, AB, $\mathrm{BC}, \mathrm{CD}, \mathrm{O}_{\mathrm{c}} \mathrm{c}$. there be found but one LightParticle.

Now fince $O E$ is fuppos'd to confift of $10^{20}$ Animalcula Spaces, the Number of Light-Particles in the fame will likewife be rot.
XV. From whence it therefore follows, that the Number of Light-Particles in the Length OE, fuppofing there be one in each AnimalculaSpace, Is to the Number of the fame, fuppo-
fing likewife, that they increafe according to the Rule Num. X. As 10옹, or fo many Units as are contain'din the Lines A G, Br, $\mathrm{C} s, \mathrm{D} t$, ©́r. Are to the Produce of all the Numbers that compofe the Perpendicular Lines $\mathrm{A} a, \mathrm{~B} b, \mathrm{C} c, \mathbf{D} d, \notin c$.
XVI. It is not neceffary to prove that the Numbers of all thefe Perpendiculars $\mathrm{A} a, \mathrm{~B} b, \mathrm{C} c, \mathrm{D} d$, Oc. do contain. fo great a quantity.

Since the Firft and greateft $A a$ being $10-$.
The Second $B b$ will amount to $10^{\circ} \frac{8}{4}$, or 250 .
The Third Cc $10 \frac{20}{9}$.

And fo forth; each of thefe Lines equal to the Line $A a$ or $10^{20}$ divided by the Squares of their Diftances from O ; all which amounting to the Number of $10^{ \pm 0}$; fo as the laft F E, by the Unit, will produce a great Sum, which to compute here would be a very great Trouble, and require too much Time and Room.
XVII. That we may not therefore be deceiv'd in our Calculation, we fhall make choice of a much fmaller Sum than we need do, and therefore only retain the Number $10^{20}-$, that alone being the greateft quantity of Light-Particles in the Space of one of the Animalcula, or the Line A $a$; and we will throw away the reft $\mathrm{B} c, \mathrm{C} c, \mathbf{D} d_{3} \dot{\sigma} c$. which would likewife amount to a valt Sum.

And having done fo, it will eafily follow; that the increafed Light-Particles $10^{20}$, or $\mathrm{A} a$ (Num. XVI.) Are to the Number of Light-Particles in OE, As one in the Space of each Animalculum, or to $10-\frac{10}{}$ (Num. XIV.) As $10^{x 0}$ to 1 . Or that (if we admit the Increafe Num. X.) the Animalcula in O E are $10^{20}$ times more, than if we were to fuppofe but one in each of the Spaces between $O$ and $E$, QR SE. This is applicable to all the Rays like OE thro' the enlighten'd Globe, and confequently to the faid whole Globe.

XVIII. Be-

XVIII. Before I proceed, I beg leave to obviate the Opinions that fome People may entertain of there Matters :
Namely, That fince the Curve-Line $a, b, c, \mathcal{心}^{\prime} c$. F which connects all the Tops $a, b, c, \psi_{c}$. of the Perpendicular Lines $\mathrm{A} a, \mathrm{~B} b, \mathrm{C} c$, $火 c$. which are here drawn fo clofe to each other, is of a known Property ; which, if we call each of the Lines or Diflances $\mathrm{OA}, \mathrm{O} \mathrm{B}, \mathrm{O} \mathrm{C}, \mathrm{w}^{\prime} . x$, and the refpective Perpendiculars $\mathrm{A} a, \mathrm{~B} b, \mathrm{C} c, \mathrm{c}^{c}$. each $y$, and the Line $\mathrm{OE}, a$, and $\mathrm{E} F, b$, and exprefs the fame by the following Algebraic Equation, $x x y=a b$. A Mathematician will wonder, perhaps, why I did not find the Area of the Magnitude of the Mixtilineum A a FE by Approximation, or even afterthe Method of Mercator, Wallis, and other great Mathematicians; to the end, that after having compared the fame with the Greatnefs of the RectAngle A G FE, to find the Proportion from thence of the increas'd Number of Particles of Light in OE to the Number of the fame OE, if there were but one Particle in the Space of each Animalculum; which has been done, it may be, by others on the like Occafion.
But they muft be pleas'd to obferve ; Firff, That I have omitted thefe Methods, becaufe all of 'em fuppofe, that the Line OE is to be divided into infinite fmall Parts, as $\mathbf{O} A, A B, B C$, ' $c$. whereas we have only adapted our Divifions to fuch Parts as are equal to the Space fill'd by each of thofe Animalcula that are vifible thro' a Microfcope, which is yet bigger an infinite Number of times than one of the infinite Parts.
Secondly, We have given one Reafon in Num. XVII. which will make our Conclufions much more acceptable, becaure we choofe fo much finaller a Number.

Thirdly, What we here write is not fo much for great Mathematicians, as for others that are of a good natural Underftanding, tho' not thoroughly vers'd in Lines and Figures; wherefore, when we can ufe other Methods of Proving, we avoid as much as poffible thofe of the Mathematicians; my chief End being to render my felf intelligible even to the meaneft Capacity, rather than to pleafe the Learned, provided I can make the Truth appear in fuch a manner.
XIX. To draw therefore thofe Conclufions which we have in View from thefe and the foregoing Principles; let us fuppofe, (t.) with Leuwenboek, that $1000.000,000$ of thofe Animalculid which are vifible thro' a Microfcope, do make up one Grain of Sand, Sect. X. (2.) That $1.000,000$ of Sands are equal to a Cubical Inch, Sect. X. according to which 10 은 of thefe Animalcita are equal to a Cubical Inch, allowing but io Inches to a Foot in length.

Now according to Num. V. the Globe QRSE contains $418660^{\circ-2}$ of fuch Inches, and confequently $418660^{26}$ of the faid Animalcula.

XX, Let us fuppofe further, that in every one of the Spaces fill'd by each Animalculum, there is but one Light-Particle thro' the who'e Globe.
XXI. If now the Velocity of Light be fo great as to enlighten this Globe in one Second, (See Num. VI and VIII.) and a Candle of Six to the Pound will burn 5 Hours, there will be $\frac{x^{\frac{1}{4}}}{5}$ part of a Grain of Tallow fpent in each Second. Confequently there will proceed from $\frac{\cdot}{\frac{1}{3}} \frac{1}{4}$ of Grain of Tallow $418060^{2-6}$ Particles of Lisht, and 14 times fo many, or $5161240^{2-6}$ from a whole Grain.
XXII. But one Grain is Part of an Inch of io to theFoot, Num . VII there p cceeds therefore from Vol. III.

Ggg
oné. or in one Number $269617040^{22}$ Particles of Light.
XXIII. But fuppofing with Mr. Leuwenboek, 1000 Diameters or Lengths of one of there Animalcula equal to one Grain of Sand; and 100 Diameters of one Sand, to be the Length of an Inch, and ro Inches the Length of one Foot.

Then $\mathbf{1 0}^{6}$ - Diameters of the Animalcula make the Length of one Foot, and ro 10 of the fame the Length of O E, or 10,000 Feet.
XXIV. Now we have fhown, Num. XVII, that altho' we throw away many Thoufands of Millions of Light-Particles in the Globe QRSE, there be really $1 \mathrm{o}^{\circ}-\frac{0}{}$ more Light-Particles, than when as above in Num. XX, we fuppofe but one fingle Particle in the fpace of each Animalculum. So that there proceeds from $\frac{-}{T} 44$ of a Grain of Tallow, $10^{\circ 0^{\circ}}$ times more Particles than are fuppofed Num. XXI; and confequently from one Inch of Tallow, $10^{\frac{2}{-}}$ more than in Num. XXII; that is, from one Inch of Tallow there will proceed $269617040^{23}$ fuch Particles.
XXV. And all this is true: Firf, Altho' we fhould fuppofe that there is but one LightParticle in the Space of one Animalculum, at the extreme Part of the illuminated Globe, or at VE, which every Body fees is too little, confidering the gradual Increafe of Light, as we come nearer to the Candie O. And Secondly, although the faid Globe fhould be enlighten'd but once in one Second, or that the Light paffes from O to E in that time.

But forafmuch as according to $\mathrm{Nam}_{\mathrm{a}}$. VIII, the Light runs 1000 times fwifter, and does not only run once, but rovo times the Length of OE on all Sides, there being 1000 of fuch Globes filld with Light by $\frac{7}{T_{4}}$ Part of a Grain of Tallow inone Secon 1.

It plainly follows, that the Number found by Num. XXIV, muft be multiply'd by 1000 ; and that one Inch of the Tallow burning in fuch a Candle does emit $269617040{ }^{40}$ Particles of Light, whereby the moft aftonifhing Smallnefs and Number thereof is plainly Demonftrated.

Sect. XVI. How many Particles of Light fly out of a burning Candle in a Second.

To know then how many Particles of Light fly from a burning-Candle in the Second of a Minute ; it has been Demonftrated from the foregoing Confiderations, that $\frac{\pi}{14}$ of a Grain of Tallow is confumed in the Second of a Minute, or, which is the fame thing, one whole Grain in 14 Seconds. Now an Inch of Tallow contains 460 Grains, fo that an Inch of Wax or Candle-Tallow is burnt in 460 times I4, that is, in 6440 Seconds; in which time if there proceeds $269617040^{40}$ Particles of Light from an Inch of Tallow, there will fly out of a burning Candie in the Second of a Minute, the Number of $418660^{39}$ Particles.

SECT. XVII. The Particles of Light compared with the Sand of the whole Earth.

And fince according to the moft exact Admeafurement of the French Aftronomers, the Diameter of the Earth amounts to $39.231,564$ Paris Feet, reckoning io Inches to one Foot, and that 100 Sands are equal to one Inch ; the Number to be taken for all the Sands that could be contained in the Earth, will require a Sum of not lefs than 32 Figures, the firft of which is a 3, and the whole too long to be expreffed here.

Now in Sect. XVI, the Number there found was 44 Figures, of which the firft was a 4.

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Now let us for Conveniency, and to prevent any Difputes, fuppofe that both the firlt Figures were a I, and the reft Cyphers or Noughts, by which we lofe an unconceivable Number of Parts:

Accordingly the Sands of the whole Earth will be $\mathrm{IO}^{1 \frac{35}{2}}$.

And the Particles of Light flying out of a Candee in a Second ${ }^{0}{ }^{43}$.

The Proportion of the one to the other, will be As I To $10^{\frac{12}{2}}$, or As one To a thoufand times a thoufand Millions.

From whence it may be concluded, that in one Second (which is commonly equal to one Pulfe of a healthy Man) there fy out of a burring Candle of Six to the Pound, many more Particles of Light than a thoufaand times a thoufand Millions of that Sand the Number the Earth can contain; or be equal to.

I leave every one to confider, whether this does not appear moft amazing to him, and whether he is not bewvilder'd, and lofes himfelf in the Number and Smallinefs of there Particles of Light, tho' there were no more of 'em; whereas every one may perceive from what has been faid, that if we had kept to a frict Calculation, the Number thereof would very far, yea unconceivably, furpals what we have here fet down.

Sect. XVIII. The Smalnefs of Parts in Solid Bodies, fuch as Copper or Brafs, \&cc.

Let us now pafs on to folid Bodies (tho' the Divifion of this Tallow may likewife be ferviceable to our Purpofe) and endeavour to fhew, Firft, That they confift of a vaft Number of different Particles. Some of the moft intelligible Methods feem among others to be the following.

1. Mr. Boyle (de Subtil. Efluv.) fays, that a Giain of Copper having been diffolved by him

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in Spirit of Sal Armoniac, did thereby communicate a vifible blew Colour to 28,434 Grains of Water.

Now if we fuppofe that each Grain of Water was impregnated with one Particle of Copper, it will follow from thence, that one Grain of Copper was divided at leaft into fo many Parts as there were Grains of Water.
But fuppofing with Mr. Boyle, that $\frac{*}{100}$ of an Inch in Length is vifible, hoo, ooo of a Cubical Inch will be likewife vifible.
And fince one Foot of Water of 64 Pounds (allowing 12 Inches to the Length of one Foot) contains 1728 Cubical Inches; the aforefaid 28,534 Grains will amount to above roo of the faid Inches ; and confequently in all thofe Inches there will be more than $100,000,000$, or one hundred Millions of vifible Parts; wherefore if there be but one Particle of Copper in every vifible Particle of Water, a Grain of Copper will be thereby really divided into fo many Parts.

Sect. XIX. The Smalluefs of Parts in Solid and fuid Matters in General.
No w how far the Parts of Gold may be really extended by human Inftruments, has been fhewn by Robault, Boyle and others.
One Proof which is as applicable to all folid Bodies as well as fluid, may be briefly fhewn in the already-mention'd Experiments of the Microfcopes of Mr. Leuwenhboek; by which it appears, that of thofe fmalleft Animalcula which he could fee thro' them ro $\frac{\text { xis }}{}$ or $1,000.000,000.000,000 \mathrm{ga}$ to the making up of one Cubical Inch. Now it is certain, that if the Particles of which a Body is compofed are fo fmall, that each of 'em are invifible to the Microfoope, that at leaft every Inch Gg g

From whence then the fame may be truly affirmed of all Metals, Minerals, Animals and Plants, in a word, of every thing that is vifible.

And no Body ought to be furpriz'd, if we flould add, that this Number of Parts is much too fmall to exprefs properly the Multitude thereof ; and that this may certainly be proved in many Cafes if it be confider'd;

Firf, That thefe fmall Animalcula which are only vifible thro' the Microfcope, muft be furnifhed likewife with the proper Inftruments for Life, Motion and Procreation, as alfo with their Juices by which they are nourifhed; to the fmallnefs of which, no Power of human Imagination feems capable of being extended.

Secondly, That almof all Animals and Plants are Combuftible, and may be put into a perfect Flame; for which Reafon, if we only make a rough Eftimate (according to what has been faid above, Sect. XVI and XVII, of the fmallnefs of the Particles of Light) how much greater the Flame proceeding from them is, than that of a Candle; and confequently, how many more Parts do every Moment fly out of them under the Figure of Light, all which did contribute before to the Structure of fuch a Plant or Animal, fuch a Multitude, and fuch a fmallnefs of Parts, will refult from thence, as (to thofe who do not fee the force of thele Confequences) muft feem incredible, and unconceivable even to thofe that can fee them.

Sect. XX. Experiments fhewing the determinate Properties of thefe fmall Parts.

Now that thefe numerous Particles which flow from Bodies, are not only very fmall, but have likewife a determinate Nature and Effence, has been fhewn by the Learned Mr. Boyle in a particular Treatife, to which we refer the Reader.

But to fay fomething of the Matter; Glajs of Antimony, as is well known to thofe that underftand the Virtue of it, being infufed in Wine, will make a Vomit, tho' the Antimony lofes nothing fenfibly of its Weight ; and the Parts of it are fo exceeding fmall and fine, that an Ounce or lefs would furnifh Vomits for more People than are in the whole City of $A m f f e r d a m$.

From whence appears, not only the fmallnefs of thofe Parts which it communicates to the Wine, but alfo that the Nature thereof is Determinate.

Gold, Silver, Mercury, it may be other Metals too, being diffolved in their refpective Menitruums, are divided into an infinite Number of invifible Particles; and they may be all precipitated, as the Chymifts phrafe it, or caufed to fublide in thofe Liquors, and be returned again into their feveral Metals.

How fmall the Effluvia are that come our of a Loadfone, and which will even pals thro' Glafs to move Iron, is plain enough from fuch an Effect; and withal, that they have their determinate Properties.

> Sect. XXI. Of the Smoak of Benjoin.

They who defire to fee a Calculation of the fmallinefs of the Rarticles that exhale'from fweet Ggg 4
or Ainking Matters, fuch as Musk, Civet, Ambergreafe, Afla Fatida, and the like, may meet 'em in Dr. Keil's Introduction, and yet they all retain their particular and determinate Scent: To fay nothing of the Particles which a Hare or other hunted Beafts leave upon their Foot-fteps, fince Mr. Boyle has exprefly treated of the fame : It may be proved from the following Experiment, without any Trouble or Charge, of how. many Particles a folid Body confifts.

In a Chamber that was 24 Foot long and broad, and about 16 Foot high, I placed little Pans of Fire in 4 feveral Places, and ftrewed upon each of 'em about $\frac{x}{4}$ of a Drachm of Benjoin ; whereupon the Chamber, after fome time, was full from one end to the other of a thin vifible Smoak.

Now the Contents of this Chamber were 9216 Cubical Feet, which being multiply'd by 1000, or the Number of Inches in a Foot (fuppofing it to be divided into 10 parts in Length) amounted io $9.216,000$ Inches.

Now $\frac{r_{1}^{2}}{500}$ of an Inch in Length is vifible to the naked Eye, (Sect. IV.) confequently then fr,ōo, ©oo of a Cubical Inch; fo that there being $1.000,000$ vifible Particles in an Inch, there were $9.216,000.000,000$ of the fame in this Chamber; and in cafe there were but one Particle of Benjoina in each, the 8 th part of an Ounce of the faid Perfume would be thereby divided into more than nine thoufand, thoufand Millions of Particles, tho' the fame be much fmaller in quantity than an Ynch.

If now we add here, not only that this Smoals diffured the Scent of the Benjoin in all parts of the Room, but likewife, as the "Chymifts know, that the faid Smoak being collected, does yield a purified Benjoinz called the Flowier of Benjoin; be-
fides the fmallnefs of its Parts, the fettled and determinate Property thereof may be proved from thence ; and that as well thefe fmall exhaled Particles do retain the Nature of the Benjoin itfelf, as the Vapours do of the Water out of which they procced, and into which, being collected, they are rurned again.

Sect. XXII and XXIII. Convictions from the Smallnefs of Parts in General, and in Particular.

Now let an unhappy Atheift, who has not underfood all that has been here faid of the Smallnefs and Multitude of thefe Particles, but who by Reading and Reflecting has made the Contemplation thereof habitual to him; let fuch a one I fay, fet before his Eyes the great Structure of the vifible World, and all its Parts; and let him confider not only of what an innumerable, unexpreffible, yea, and unconceivable muititude of Atoms the fame confifts, but particularly, that none of 'em all have the leaft Knowledge or Skill to create or move themfelves; and let him judse farther, that if no Wifdom had intervened in this Matter, and that all their Motions had been produced without any Order, and by meer Chance; whether it would not be certain, that this noble Frame of Heaven and Earth would have been quickly turned into a Chaos, in which Fire, Water, Air, and all things befides, would have been confufedly jumbled among each other; and fo much the more, if there had nor been a Power fo unconceivably Great, as to extend itfelf to every Individual of all thofe thoufand thoufands of unexpreffibly many Millions of Millions, and which could have directed and governed each of 'em in Particular ; which Direction is therefore neceffary, becaufe each of 'em have their determinate

Properties; and therefore one kind of 'em is not adapted for executing fuch a Purpofe as may be pertormed by the other.

Or if this Proof be too General for thefe miferable Philofophers, fo that they will fancy to themfelves, that perhaps they may find out here or there fome Subterfuge among this great Number of Objects, let them cait their Eyes upon Particulars : Let them read all the modern Difcoveries by the help of Microfcopes; let them apply themfelves to fee with their own Eyes what they had heard before thereof; and that travelling thro' this new World, which for fo many Ages has been Invifible, they may Contemplate thofe numberlefs ftrange Things, which would have been incredible, if Experience had not render'd them certain : And when they have been affured by their own Sight, that for Inftance, fuch a little contemptible Creature as a Mite in Cheefe appears to the naked Eye, is a a compleat Animal, having all thofe Limbs and Joints that are proper for its Motion, and its Body cover'd with Hair ; that fuch Infects couple with each other, lay Eggs, from which their young ones are hatch'd; that farther on the contrary, the little Eels that may be difcorer'd in Vinegar, lay no Eggs, but bring forth their young ones alive. This laft we are told by Mr. Huygens in his Dioptrics, p. 227; where he fays, that he faw in fuch an Eel four young Eels (for they are entirely tranfparent) and that after having kept the old Eel a little longer in the Glafs Tube, the four young ones were obferved fwimming by their Dam.

And if this Contemplation alone may have fo. much Power over them, as to force them to confefs, that an over-rulirg Wifdom prevails in all thefe Matters; the Emailnefs and innumerable

Mutritude of thefe Objets in which its wonderful Operations appear, will eafily convince them, that there muft be fomerhing Divine thercin; and it may ferve at the fame time to illuftrate that great Article of Chriftianity, namely, That even the moft minute Things cannot by their Smallo nefs efcape the Direction and Providence of the great Creator.

Sect. XXIV and XXV. The Hand of God particularly manifefed in the Ufe of thefe frall Parts.

Let not then any Infidel who only reads the Bible to form Objections againft it, imagine any longer that it was almoft an incredible Hyperbole ufed by the Saviour of the World, when he was pleafed to fay, Matth. x. 30. That the Hairs of our Heads are all number'd: Since we have fhewn a Providence, exerting itfelf with Refpect to thofe Animalcula, that can by no means be compared with one fingle Hair for Greatnefs; and fince in one Second of a Minute there are more Particles of Light diffufed from a burning Candle on every Side (all which, as the Mathematicians know, are moft exactly governed and direfted by the Laws of Optics) than there are Hairs upors the Heads of any one Man living, tho' that Perfon had as many Hairs upon his Head as there are People in all the World.

To fet this Matter in a true Light, tho' it may be very eafily deduced from the foregoing: It has been fhewn in Sect. XVII, that the Number of Particles of Light that proceed from the Flame of a Candle in one Second, is much greater than a certain Number, the firf Figure whereof is 4, followed by 43 Noughts, or $40^{93}$.

Now Mr. Leuwenhoek in his Firft Letter, p. 14." finds that the Number of Men upon the whole Earth $_{2}$

Earth, according to his Calculation, amounts to $13,385.000,000$ or $133850^{6}$. Now let uscompute this Number at above much more than io times the fame, and fuppofe it to be $20^{ \pm 2-}$.
Now if every Man had fo many Hairs upon his Head as $20^{-1}$ (which is much too many) the Number of the Hairs of all Men would be $40^{22}$,
 part of the Particles of Light that proceed from a burning Candle ; fo that from hence we may conclude with the utmoft Certainty, that the Son of God far from ufing an Hyperbolical way of fpeaking, falls much fhort of the ordinary Operation and Direction of his Providence, how figurative foever this Expreffion may appear to weak Men.

Befides all this, it may perhaps be an. Inducement to an Atheift to acknowledge a God, if he confiders, that this adorable Creator and Governour of all Things has thought fit to fhew particularly thereby his Godhead and Sovereignty over all his Creatures; that in order to produce the greateft and moft furprifing Events and Things, he oftentimes makes ufe of no other but thefe fmall Particles, thefe contemptible Atoms or Points, making infinite numbers of the fame fubfervient to his wife Ends and Purpofes.
To prove this Experimentally, the whole World may in a manner ferve for an Example ; for to fay nothing of the fmallinefs of thofe Particles which caufe Peftilences and contagious Diftempers, whereby fo many thoufand Men are often fnatched away in a little time (in which therefore King David acknowledged the Hand of God appearing after an eminent manner; i Sam. xxiv. 14. and which even at this time are called by many the Gift of God; ) how fmall and nume-: rous are the parts of Water, of which above a thourand
thoufand times a thoufand Millions are neceffary to make up one Drop, or one fingle Hail-Stone equal to the Weight of one Grain? And to how great Purpofes are they ufed, for which Water would be entirely unfit, if it were not capable of being feparated and divided into Particles of an innumerable Multitude, and of an unconceivable Smallnefs? How many thoufand Millions thereof afcend daily out of the Seas and other Streams? How many of 'em float in the Air, and that we may not repeat what we have faid before in the Contemplation of Water, how many fall down in Rain, how many in Snow, how many in Hail, how many in Dews and Mifts; how many are employed in the Nourifhment and Increafe of Plants, and in Drink for Animals; bow many in barren Wilderneffes, and for the Support of the wild Beafts therein ? And muft it not be confeffed, that all this depends upon the Divifibility, and upon the actual Divifion of Matter into an infinite Number of fmall Particles.

Sect. XXVI. Convictions from the Smallnefs of the Particles of Air.

Now tho the innumerable Multitude of the Particles of Water only might feem fufficient to convince the moft harden'd Atheift of the DireCtion of God in thofe great Events, which tend as well to the Advantage as Punifhment of Mankind ; yet if that can't fatisfie him, let him confider the Air in the true State thereof : And if he has any Knowledge of Nature, he will admit it as an indifputable Truth, that the Subitance of the Air is a Collection of innumerable Diverfities of fmall Parts, which aeting upon each other, do oftentimes exert fuch a Power as furpaffes even all Belief. Let him only read concerning this Matter,

Matter, the Hiftories that give us an account of the dreadful Force of Storms and Tempefts, of Thunder and Lightning: Now 'tis plain, that all thefe terrible Effects are brought to pafs by Particles, which are fo fmall, and fo light, as to be able to float in the Air; and that Lightning particularly finds no Pores of the very hardeft Bodies fo clofe and narrow but what it can penetrate.

We have mention'd fomething of the Air above in Sect. XIII. but which falls far fhort of expreffing upon thofe Principles the Smallnefs and Number of its Parts; and if in one Pulfe or Second of a Minute there do proceed fo many thoufand Millions of Particles of Fire and Light from the fmall Flame of a Candle, how vaft muft the Number be of thofe that proceed from greater Lightnings, and how fmall each fingle Particle thereof ?

> Secti XXVII. Convictions from the Smallnefs of the Particles of Fire.

And for greater Conviction, let him farther add Fire or Light to Water and Air, and he will find not only that the Parts thereof are unconceivably Small and Numerous, but alfo that the Powers of it are moft Terrible. Not to fpeak again oflightning, which is an amazing Inftance thereof, he who has ever read in Memoirs, how by the Violence and Number of thefe fmall FireParticles, Subterraneous Caverns have burf open, and caus'd Earthquakes; whole Rivers have flowed with burning Matters; Cities and every thing in them, have been deftroyed; Rocks and Mountains fplit afunder, and fometimes vaft Pieces of them, which did not feem capable of being moved by any human Strength, toffed up into the Air to an incredible heighth; muft not he acknowledge
that all thefe ftupendous Effects have been brought to pafs by the molt minute Particles of Fire, and fuch as could hardly be conceived for their Smallnefs ? That he may fatisfie himfelf thereof without much trouble, let him only look back to Sect. X VI, and confider what has been there faid about it, namely, that from fo fmall a Flame as that of a Candle, there proceeds in the Second of a Minute a Number of 41,866 with 39 Cyphers following, of Particles of Fire and Light.

Let him now compare therewith the Flames of Lightning, of burning Mountains, of all the combuftible Matters in the Eatth, fuppofing them to be inflamed; that mighty Globe of Fire the Sun, and perhaps likewife thoufands of fix'd Stars; and then let him reflect with Amazement, how great an Hoft of numberlefs Particles of Light and Fire are to be found in the World; for, that no Man living is able to compute the fame, I believe he will readily agree.

Now fince this dreadful quantity of Light and Fire-Particles does not fet the World in a Flame (the Poffibility of which has been already exemplified in Burning-Glafies) it is plain enough that they mult have been reftrained by fome fuperior Power from making fuch a Havock and Deftruction.

And now if a Sceptick is defirous to fee, and as it were to feel with his Hands a divine Directiof thefe Particles of Light and Fire, he needs not Contemplate all the combuftible Bodies in which fo many thoufands of 'em lie dormant, and as it were lock'd up and fetter'd till the Time that they are to be put into Operation (which likewife proves the Direction of a Superior Power) but let him only confider the Optical Experiments, which will convince him; that all and every Particle of this vaft quantity of Light, are fo ftrictly bound to fparent Bodies, they are compelled to adapt their Motions to the Diverfity of their Figures, and even to unconceivable Circumftances; with Inftances of which, Sir IJaac Newton's Optics abound.

## Sect. XXVIII. Convictions from all the foregoing.

If all this be not fufficient, let a Man who ftill doubts of thefe great Truths, reprefent to himfelf of what fmall Particles not only Water ${ }_{j}$ Air, Light and Fire, but even without Diftintion all other vifible Bodies whatever are compofed. To begin Firf briefly with Plants and Animals, which are fubject to Comburtion and Putrefation; what fmall Veffels and Tubes through which yet fmaller Particles of Saps and Juices do pars, are difcover'd in the fame by the help of Microfcopes? (about which Mr. Leuwenhboek and others may be confulted) How many Fat and Oleaginous Parts are to be found in the fame? (of which likewife Candles are made from fome Animals, an Inch of whofe Fat is divifible into fuch an unconceivable Number of Parts by Inflammation, as we have fhewn above Sett. XV and XVI.) How fmall and sumerous are the Particles which from Putrefaction fill fuch great Spaces of Air with Stench? How much Water proceeds from thence by Diftillation? Which in Sect. XI. has been fhewn to confift of fo numerous and fmall Particles; and when all thefe, both Animals and Plants, have undergone the utmoft Corruption, they are changed into a fruitful Earth and Matter ; How many Particles, efpecially if viewed with a Microfcope, might we find in the fame Earth? Now if we - caft our Eyes farther upon Metals and Minerals, thofe Glaffes will likewife convince us of the fmall-
caft our Eyesfarther upon Mctals and Minerals; thofe Glaffes will likewife convince us of the fame Smallnefs of their Parts; and yet more, if they be diffolved in Aqua fortis, and moft of all if they burn, or tinge the Flame with their Particles.

To make an End: After having read all this, and what more can be met with upon the fame Subject from other Inquirers, I think we may fafely affirm, that every thing that is vifible in the World is compofed of an unconceivable Number of various Particles. Let an Atheift therefore reprefent to himfelf this innumerable Quantity of thoufands of Millions, and confider, Firft, Of how many different Kinds they confif, which are each of a particular Nature. Secondly, How many kinds muft be often made ufe of in the Compofition of one only Body, as we find by the modern Obfervations of Chymifts, and others, who extract from every Plant or Animal, Air, Fire, Water, Salt, Spirit, and Earth, in fo great a Diverfity; how many various Compofitions they make ; how from the fame Seas and Rivers, Air, Clouds, Winds, Sun, Stars, Trees, Shrubs, Herbs, Flowers, Fruits, Bodies of Men, and other Animals, fuch as Birds, Fifhes, Beafts Earth, Sand, Stones, Meta s, Salts, and a thoufand other Things, that have each their Singularities and Properties are produced. Lafly, How, only by the Difpofition of the Particies and Atoms which are in themfelves invifible . this Great, this Wonderful Univerfe is maintain'd in its State and Condition, and all Living. Things are preferved.

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Sect. XXIX. Great Bodies are for the moft part divided at firft into Small Particles, before God is pleajed to make ufe of them.
$A_{n d}$ thate we may fee how often the wife Director divides great Bodies into fuch fmall Particles, before He thinks fit to make them become Inftruments of his Power ; let us confider of how little Ufe and Advantage Water, for Inftance, would be whilft it remained Ice, or a great hard and folid Body, in comparifon of what it is when fluid, and divided into Millions of Particles: Whilft it remains Ice, can it fo conveniently fupply Drink to thirfty Animals, or Nourifhment to Plants? Can it bear loaden Ships and carry them through the whole World ? Can it afcend into the Air in order to come down again in Rains and Dews, or render thofe innumerable Services which Men reap from it when divided into minute Parts?

Whilf Fire being collected and fhut up in Turf, Wood, Coals, and other combuftible Matters, compofes great and folid Bodies, what Effects can it produce in fuch a State? And unlefs thofe great Bodies be firt divided into fmall Particles and Flame produced by the Motion thereof, can they be any ways ufeful for Warmth, for Light, for melting Metals, for preparing Food, and other neceffary Purpofes?

The mof adive Matter that we know of amongł humane Compofitions, is Gunpowder: What can it do whilft it is only Salt-Petre, Brimftone, and Coals? But when thofe fmalleft Parsicles of which it confifts, are let loofe and put into Motion, what is there in all Nature here upon Earth, and round about us, that can refift its Violence? Infomuch that even Thunder and Lightning,

Lightning, which are obferved to be the moft terrible Powers in the World, tho' they likewife are compofed of fuch fine Particles as are capable of floating in the Air, are-fo exactly imitated thereby, that he who fees the Flame of the former, or hears the Noife and fometimes feels the Earth trembling under his Feet, has oftentimes reafon to doubt whether it be not really natural Thunder and Lightning which produces thofe amazing Effects.

We may learn from hence, as from an Experiment made and ferving only for that Purpofe, how great the Force of the Particles is, which, as far as our Inquiry can extend itfelf, mult be efteemed the moft minute of all, fuch as fimple Fire and Light.


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## CONTEMPLATION XXVI.

Of Certain LAWS of NATURE.

## SECT. I. What a Law of Nature is.

WE underftand, by this Expreffion, nothing more here than 2 kind of Property or Power producing fomething in or about Bodies or their Parts, and which may be experimentally proved in certain Circumftances to have always place in the fame ; but we fhall not pretend to a deep Scrutiny here, whether they be produced immediately by the Firft Caufe, or by Second or Intermediate Caufes acting in or about them.

## $S_{\mathrm{Ec}} \mathrm{c}$. II. The Laus and Powers of Cohefion.

If then we reflect on the inexpreffible Number and unconceivable Smallnefs of the Particles of Matter of which the Univerfe confifts, even the moft obdurate Atheifts cannot deny, that Laws are neceffary in order to produce this beautiful World, and all that is to be found therein. And if every thing were moved by Virtue of mere Chance, working without Rule or Order, (juft as if little Particles of Duft were blown by different Winds) no body that is reafonable but muft confefs that he could expett nothing but the ntemof Confufion from thence.

The firft Law or Power then that occurs to us, is, that of Cobefion, whereby certain determinate kinds of Atoms are faften'd to each other, in order to produce together certain determinate particular Effects.

Let then an unhappy Philofopher tell us, when he fees fo many Men, Beafts, Plants, Heavenly Bodies, and what elfe can be reckon'd among Corporeal Beings, formed with fo great Regularity and Order by fuch a Cobefion of Parts, whether there be not infinitely more Wifdom required thereto, than to build a Houfe of the neceffary Materials of Wood, Stone, Iron, Glafs, © cc. fup- $^{\text {. }}$ pofing them to be all prepared and brought together for that Purpofe, and certainly he would not afcribe this latter to Chance, or the ignorant Laws of Nature only.

Now with how great a Force the Parts of fome Bodies, fuch as Flints and other Stones, Diamonds, Iron, and other Metals do cobere, is manifeft by Experience, and particularly from the Violence that is requifite in many, to feparate the Parts from each other. But if any one fhould objeef, that this Cobefion is only produced by Reft of the Parts among one another, and that in order to continue Bodies in Reft, there is not fo much Wifdom or Power neceffary; he may learn from Mr. Marriotte de Perculf. Part II. Sect. 2. and from Mr. Huygens, Sect. 3. that he is miftaken therein, thofe Gentlemen having proved, that a Body, how great foever, upon the leaft Percuffion or friking of another, how little foever it be, lofes its Reft; and is put into Motion; which however is never experienced in hard Bodies, the Parts of which (were they as hard as poffible) if they only cohered by Reft, might be blown away and fcatter'd with the Breath of ones Mouth, like a Heap of Duft.

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Befides the Greatnefs of this Force of Cobefion, it is likewife wonderful to obferve the Variety thereof, by which every thing is and remains adapted to its proper Ufes after a particular manner. Thus if all the Parts of the Tongue cohered, or were fo ftrongly joyn'd together as thofe of the Teeth, it would be immoveable; and if the Teeth were as foft as the Tongue, they would not be fit to grind our Food: If the Parts of Corn, and other Meats with which Men and Beafts are nourifhed, were as hard, and cohered as clofely as Iron and Flints, the Earth would be foon difpeopled. If therefore any one be ftill fo blind as not to difcover in the Manner and Variety of Powers of this Cobefion, or of the Hardnefs and Softnefs of Bodies, an infinite Wifdom; why does not he maintain likewife (to ufe a courfe Comparifon) that our Beds and Blankets are foft, and the wooden Frames belonging to 'em are hard by meet chance, and without the Defign of the Workman?

Sect. III. The Laws and Powers of Sepaiation.
Now if all the Parts of Matter fhould be fubject to no other Laws but only thofe of Cobefion, the World would be filled with all the Carcaffes of Men and Beafts, with all the rotten and putrified Plants, as with an odious and loathfome Burthen; and every thing remaining without any Alteration in its Corporeal Figure, would be entirely ufelefs to many Purpofes. Now can an unhappy Sceptick obferve herein no Wifdom of the great Governour of the Univerfe! Forafinuch as thofe very Parts, which in other Circumftances did before ftrictly cohere, are compelled to obey other Laws and Powers, and to feparate themfelves from each other. By this Means the World

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is disburthen'd and releafed from fo many unncceffary things, the Parts of which are divided from each other by Fermentation and PutrefaEtion ; and afterwards again feveral other Matters are formed thcreof, as for inftance, the moft fruitful Lands, and many other Advantages do refult from thence, of which a Multitude of Examples might be given, but we fhall mention no more here, having already fpoken of this Circulation of Matter upon other Occafions.

SECT. IV. The Unattrition of Such fine and tender Particles.

Bur there's ftill a Law and Power, which will amaze every one that reflects upon it, namely, That thefe Particles of Matter, fo fmall and fo fine, fhould have continued for fo many Ages without Attrition, or wearing away; notwithfanding that they have undergone fo many Frictions or Rubbings, fo many Perculfions or Strikings among themfelves, or againft other hard Bodies, befides Motions innumerable; infomuch that it fhould feem, that in fo many hundreds of Years they would have been entirely ground to Atoms, or all their Angles and Corners, being worn away, become round; which Figure Experience teaches us to be the laft that all Bodies affume, before they be perfectly bruifed or ground away: Who can imagine, that it fhould be poffible that the Particles of Fire, after fuch dreadful and raging Motions among each other ; the Particles of Air, after violently ftriking by Thunder and Lightning, by Hurricanes and Storms, againft other hard Bodies; the Particles of Water, after fo many Frictions, for Ages, againft fandy and fony Beds and againtt Rocks, fhould fill preferve the neceffary Forms, were it not that this Law of Unat$\mathrm{Hhh}_{4}$
trition
trition of the fmalleft Particles did obtain in Nature? or that others were continually produced in juft the fame Number, neither more nor lefs, in the ftead of thofe that were confumed, both which would prove a Divine Providence.

Sect. V. Truo Principal Laws of Nature, Percuffion and Attraction, $\mathrm{e}_{\mathrm{C}}$.

From thefe Powers we fhall now pafs on to others, of which there be two principal Ones, and according to the Laws of which moft Bodies difpofe themfelves: The Firf is Percuffion, the Second is, by very grear Mathematicians of this Age, termed Attraction; to which fome likewife are wont to add confequentially, the Power of Repulfion.

Two Bodies are faid to frike when one of 'em guns againft the other, which is at reft, or likewife if the laft meets the firft ; as alfo when the laft running flower than the firf, is overtaken, wherher the Way along which the Motion happens be in a Right Line or Oblique with refpeat to each other.
We don't here difpute whether fome Philofophers are in the right, in deducing almoft all Caures of natural Appearances from thefe Percuffions ;but that there is an infinite Number of fuch Motions at all times in the World, is unqueftionable. Let us only confider the unconceivable Number of Parts of which Fluids confift, and imagine that many thereof, as Air, Light, Fire, Water, '̛'c. are in continual Mution, which could not happen without Millions of Percuffions againt one another in an Inflant : Now if there were no Laws obferved by them herein, let us think what a Confufion ali things would be in.

Now what thefe Laws are, have been fhewn by Wallis, Wren, and Huygens; and Sir Chrifopher Wren in particular has proved, that the fame do experimentally agree with the Things themfelves which Mr. Mariotte has thought fit to defcribe in a diftinct Treatife. Now let an Atheift confider whether it can be withouta fuperior Direction, that fo many thoufand Millions of Bodies, all of 'em entirely ignorant of what they are doing, fhould have fo ftrictly obey'd the Rules of Mathematicks for the Space of fo many Ages.

And fince among thefe Laws that are obferved in the Percuffion of Bodies, there are likewife found fuch which may indeed be deduced by confequence from others that are intelligible ; bat of which notwithfanding the Manner how thefe Laws are performed, is incomprehenfible to every one; let an Atheift think whether we ought not to conclude from the Incomprehenfibility of the Manner of the Operation, the Incomprehenfibility of the Operator himfelf, and thereby acknowledge a Wonder-working God.

To give an Inftance thereof here, it is obvious to thofe that underfand the Mathematicks (but who can comprehend the How thereof?) that a Body in the Percuffion does communicate not only a greater Degree of Velocity, but alfo a greater Force and Motion to another, than it firft had it felf, and yet almoft retain all its own : The great Philofopher for Motion, Mr. Mariotte, calls this, in his Treatife of Percuffion, p. 153, 154, a very furprifing Paradox, and a few Lines below, a woonderful Thing; and that he might leave it paft doubt, proves it experimentally.

And Mr. Huygens demonftrates, in what he has writ upon this Matter, that if one placed a hundred Bodies next one another in Reft, of which sach following was always half as big as the pre-
ceding ; and in cafe the Motion begins from the biggeit, the Velocity with which the fmalleft would proceed, would be $14,760.000,000$ greater than the Velocity with which the biggef was moved; but in cafe the Motion begins from the fmalleft, the Greatnefs of the Motion in the whole will be fo muchithe more augmented, As $4,677.000,000$ is more than an Unit.

Mr. Whiftonhas transferr'd this from Mr. Huygens into his Pralect. Pbyf. p. 55. and names the Firft, a wonderful. Augmentation of Velocity; but the Laft, a more wonderful Augmentation of the Greatnefs of Motion. To pais on now to a fecond Kind of Powers:
It is faid, that the Body A (Tab. XXIV. Fig. 2.) has an Attrattive or a Repulfive Force (Vim Attraiticem vel Repellentem) or otherwife, that the Body B gravitates to the Body A, when we fee that another Body B is moved towards, or driven from $A$, without the Intervention of any other Bodies, which by protruding the faid B , may be affirmed to produce fuch Motion.

A Philofopher who afcribes all to Percuffion and Protrufion, muft not chink he has a Right to deny the Action of thele Powers, becaufe he can't comprehend the Manner after which things thus happen ; forafmuch as, according to fuch Notions, we might reject many things likewife which Experience prove really to come to pafs. Who can conceive the How of what has been fhewn to happen about Percuffion, or about the Operations of Light in Contemplation XXIV ? How many Effects are there in Chimiftry, as likewife in Hydroftaticks, of which we have not yet been able to comprehend the Manner how they come to pafs? No more than of what has been faid in Contempl. XXIII. about the Bodies and Roots of Plants, which perhaps would be as hardly admited as this DoEtrine of Attraction and Reprofion, if nothing mult
bebelieved to be true, but that of which we can underftand the How and the Manner. Thofe therefore who make other Scruples and Difficulties, may confult the famous Writings of Dr. Gregory, Mr. Whifon, and others, who have illuftrated the Phyficks of Sir Ifaac Newton, and allow of fo many of the Arguments which are there ufed to demonftrate this Attrattion and Repulfion, as they think they fully proved the fame.

Now to fhew briefly, that thefe two Powers of Nature are not fupported by a mere Hypothefis, but that we fee by Experience, that one Body is moved towards the other, and one Body driven from another, while no Man has ever yet been able to prove by any fatisfactory Arguments any fuch Matter, to the protruding Faculty whereof thefe Effects can be afcribed: Let thofe who are not yet convinced thereof, obferve another Property of Matter, namely, that all Things are beavy, or do gravitate and move towards the Earth, or Center thereof: After the fame Manner alfo the Planets are carried towards the Sun, the Satellites or Moons towards their primary Planets; and yet no body has been able to fhew to the Satisfaction of all, what has been the Caule thereof; and even the Arguments that are produced to prove the contrary, do not want their Weight; all which maybe feen in the Works of the above-mention'd Gentlemen.

That which we have quoted in Comtemplation XXIV. about Light, from Sir Ifaac Newton, (which he fays in his Opticks, p.336, to be incomprehenfible to fuch as follow the vulgar Hypothefes) is in $p .350$ of the fame Treatife fo accurately folved by that Gentleman according to to the Laws of Attraction, and confirmed by fo many experimental Truths, that it would be very difficult, without fuppofing an Attraction, to difcover any probable mittry furnifhes us with numberlefs Examples of fuch Motions in its Effervefrences and Conjunctions of Bodies and Saits, and in its Precipitations or Separations of Bodies; both which do plainly reprefent an Attraftion and Repulfion. The Caufes, if there be any, among the Bodies that are near each other, we fhall not here inquire into, and even Mr. Mariotte feems, in his Treatife of Vegetation, p. i5, to acknowledge fuch a Motion, which he calls a Motion of Union, and feems to underftand thereby fomething analogous to this Attration.

## $\mathrm{S}_{\mathrm{Ec}} \mathrm{t}$. VI, and VII. Gravity and its Effects.

To come to the Particulars of fome of thefe Laws of Nature :

One of thofe Appearances of Nature which are fo familiar to us, that it is daily look'd upon by the moft ignorant Men without any Surprife, namely, the Gravity of all Bodies, has often occurr'd to me as an irrefragable Proof of a Wife, Powerful and Gracious God, and let him who has not yet been convinced by any other Arguments, ferioufly reflect with himfelf, whether it could have happen'd by mere Chance, and without any Defign, that every thing which we call a Body, and which is to be found here upon Earth (for we fhall not now take any notice of thofe things that are beyond it) falls, or is driven down with a certain Force, and by the fhorteft Way towards the Center of the Earth; and even when hinder'd by a refifting Power, or any other invincible Ob fruction, ftill prefles thitherwards, and ofttimes with fo great a Violence, that we fee the Floors of Chambers, when loaden with too great Burdens,

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Burdens, and even whole Houfes, link down thro ${ }^{\circ}$ the Force of fuch a Preflure.

And thofe who would deduce all thefe Effeers from the Laws of Percuf $\sqrt{2}$ in only, muft at leatt be convinced hereby (fince fuch Preffures cannot be deemed compleat Motions) that there are other Laws that obtain in the World, and other Powers operating, than only thofe Percuffions which proceed from Local Motion.

Particularly, that we may be convinced of the Diredion of a Divine Providence, let us confider, Firf, What great things are brought about upon the Earth, by this fimple Law of Gravity. By this alone it happens that the Globe of the Earth continues in its firf State, and remains hanging upon its Center as upon nothing ; that the Sea remains hanging upon its Bottom which is heavier, and furnifhes Men with all thofe Conveniencies we have formerly mention'd ; by this Gravity Rivers flow, which would otherwife ftand ftill and be turn'd into putrifying and ftinking Lakes; by this the Rains, Dew, ©c. defcend from the Clouds, and moiften the Earth, caufing it to bear Fruits for the fupporting the Lives of Men and Beafts, and providing Drink for all Creatures: 'Tis by this Gravity that Boats and Ships can fail upon Rivers and Seas, and that thofe Waters are difpofed and rendered proper to bear vaft and heavy Burdens upon their Backs; and whereby the Art of Men does produce fo many agreeable Fountains and charming Cafcades that adorn the Gardens of Princes, and caufes Brooks to run from Mountains, and Pumps to raife Water, and innumerable other Ufes, that are owing only to the Gravity of Water: ${ }^{3}$ Tis this that caufes Fire and Smoak to mount upwards into the Air, ans puts in Action the Elaitic Powers thersof, which, if the lower Air were nor geoted by the Weight would be immediately fuffocated, even the Fifhes, as we have faid before, could not continue under Water without dying; nor could one only Particle of Water (of which there are fo many Thoufand in one fingle little Drop) afcend into the Air when the fuperior Preffure were removed; as alfo the Water kept up in the Clouds, being at once fuddenly poured down, all Rain and Dew would ceafe from thence forwards; and thus this bealltiful Globe of the Earth, together with Men, Beafts, Trees, Flowers, and Herbs, would be abandon'd to a general Deftruction: And if we were to reckon up all the Ufes of Gravity, any one that is but the lealt verfed in natural Inquiries, muft be convinced, that it is no Hyperbole to fay, that they would fill a whole Book.

Sect. VIII. Heavenly Bodies gravitate towards each other.
$\mathrm{But}_{\mathrm{T}}$ it is aftonifhing, what modern Obfervations have render'd very probable, namely, That this Natural Law of Gravity extends itfelf thro' the whole vifible Univerfe, and feems to prevail over all, even over the great Heavenly Bodies, which gravitate towards each other in the fame Manner as the fublunary Bodies feem to tend here with us to the Center of the Earth ; upon which Foundation the whole Phyfical Syftem of Sir IJaac Newton, who feems to be chiefly followed by the great Men of this Age in many things, is built. But I don't here undertake to found my felf upon the bare Opinions of any Philofopher, forafmuch as they are often contradicted by others, fo long as the Experiments are not only not unconteftably, but likewife not fufficiently known ; I fhall therefore
therefore only endeavour to reprefent fome few of thofe things that appear true by Experience, for the Advantage of thofe for whom we are here writing.

It is plain, by Experience, that all Bodies being once put into Motion, purfue their Way in one and the fame Right Line, if they do not meet with any Obftruction, nor are turn'd out of their Way by another Power; fo that whatever is moved circularly, as in Tab. XXII. Fig. r. the Stone A in the Sling S A, being let loofe, will purfue its Way according to the ftrait Line A F which touches the Curve A H D E.

Now it has been proved by Obfervations, yea and admitted too, without any Difpute, by the molt, if not all the modern great Aftronomers, that the heavenly Bodies, as A, (Tab. XXII. Fig. 5.) which they call the Planets, move about the Sun S, in a Curve Line AHD Z, which is not circular, but what the Mathematicians call an Ellipfos, at leaft comes very near to it.

And again it is plain, by what has been faid, that a Planet being in any Point, fuch as A G, Wc. of this Ellipfis A E D Z, would purfue its Way according to the Right Lines AF or GI, which touch the Ellipfis at A or G, and fo would entirely forfake the faid Curve Figure, which it defcribes, were it not that another Power did continually caufe it to approach or incline toward the Sun S, whofe Force reprefents the Lines F G and HI, fo that we fee, that from the Courfe of each Planet a plain Proof may be brought, that there is an active Force that attracts it every Inftant to the Sun S.

Lafty, Experience teaches us, that the fame Power of Inclination obtains not only in the great Planets that move about the Sun, (Tab.
XXII. Fig. I and 2) with refpect to the faid Sun, but likewife in their Satellites; for Intance, in thofe of Fupiter F, and Saturn H, in relation to the fame Planets, fince thefe are commonly attracted to their primary Planets, after the fame Manner as thofe Planets are attracted to the Sun, or exert a Motion by their Gravity towards the fame.

Sect. IX, and X. A ftrong Proof that the Heavenly Bodies gravitate towards each other, and Convitions. from thence.

But befides all this, I muft not pafs by a Remarkable Obfervation related by Mr. Whifton; Pralecz. Phyf. p. 289. who fhews experimentally, that befides this Gravitation or Attraction between the Planets and the Sun, and between the Satellites and their Primary Planets, there may be vifibly difcover'd the like Attraction between one Planet and the Satellites of another. Thefe are his Words, fo far as they relate to this Matter.

For as Saturn H (Tab. XXII. Fig. i and 2) remained fome Years ago a long Timé about its Conjunction with Jupiter, F, (that is, when Saturn and Jupiter are at the neareft to each other, and we fee from the Sun S, Saturn at V, and Jupiter at F , in, or almoft, in a frait Line) and confequently it muft neceffarily follow, that Saturn, by reafon of the Greatnefs of its Body and its Nearnefs to Jupiter, (for it is by both thefe that the Force of AttraEtion is regulated according to Mr. Whifton) muft occafion fome remarkable and vifible Effects in the Satellites of Jupiter; if that planet with its Satellites be attrazted to Saturn; and fo the Matter is really found to be, and the Satellites of Jupiter do change their ufual Courfe in this Nearnefs of Saturn agreeable to the Said Law of AttraEZion. So that even the fo juftly efteemed Aftronomer Mr. Flamftead, who would not at firf allow of this
this Attraction in the Heavenly Bodies, after having made the mof accurate Calculations, did frankly confefs, that this Law does likewife obtain among them in full Perfection.

Now let any one who hitherto has doubted of God's directing Power in the World, judge from thefe Experiments, whether there be not a wonderful Force acting upon thefe vaft Globes (whofe Magnitudes are not wont to be meafured by Feet, Fathoms or Miles, but by whole Diameters of the Earth; and whereof one, namely $\mathcal{F} u$ piter, contains 8000 of the fame) which Power fo violently protrudes thofe Bodies without any Inftruments, that no Cannon Bullet can be compared to the fwiftnefs of their Motion; and at the fame time does fo direct the manner of thefe violent Motions likewife, without ufing any vifible Means, that they are obliged (in fpight of the unconceivably ftrong Efforts, which they inceffantly make, to fly out of their Orbits,) to obey the prefcribed Laws of Attraction or Gravitation towards each other in every the fmalleft Point of their Way; and thereby to determine their Motion within fuch narrow Bounds, even fo far, that thefe Planets at a greater Proximity to each other, do by the fame Laws continually depart farther from each other, and fo render an Obedience thereto according to the moft exact Rules.

Finally, After all this, let the unhappy Atheilt confider, fince all thefe Heavenly Bodies are driven or attracted with fo dreadful a Force towards each other, whether it happens without Wifdom, that they having for fo many Ages moved according to thefe Laws, have not at fome time or another fallen foul or ftruck againft each other in fuch a manner, as to burft in a thoufand Pieces; the rather, becaufe even fome of the principal Mathematicians maintain, that it is polible that Voz. III. the Comets, they may yet run againft the Globe of the Earth, and fo produce a Percuffion between two fuch fwiftly moving Bodies, which no Body can think upon but with Terror: But of this laft fort of Heavenly Bodies, fince we know fo little of 'em, excepting what is liable to Difputes, we fhall make no farther mention here. This is certain, that unlefs an Atheift does abfolutely deny his own Principles, and allows that an unconceivable Wifdom and Power working without vifible Means, has place in the World, he will live in a continual fear, that the like Misfortune may befal the Earth upon which he dwells : For that thefe Laws according to which fuch great Bodies, none excepted, do continually endeavour to approach each other, can be afcribed to any other Caufes than merely to the Will of the fupream Director, does not feem to me to have ever yet been proved by any Body.

> Sect. XI. The Operations of Gravity in Bullets and Bombs.

Neither Time nor Place will permit us to produce here any more of all thofe Arguments from Mechanicks or the Science of Motion, by which we could ftrongly prove a directing Wifdom, fince all the Motions of Bodies running againft, or among each other, even to the very fmalleft, are found to obferve certain Laws, which could not proceed but only from an Underftanding and Powerful Being, fince they are regulated according to Reafon and Judgment.

The aforementioned Gravity feems alone to give fufficient Proofs thereof in thofe Things which are every where obferved among us upon the Superficies of the Earth.

And for greater Confirmation, what is there in the World more Untractable, more Ungovernable, than the Motion of the Parts of Gunpowder when 'tis fet on Fire? And who could have imagined that thofe Motions in the difcharging of Bullets from Guns, and toffing of Bombs from Morters, do always obferve the Laws of Gravity prefcribed to them in their dreadful Force and Swiftnefs, with fo much Accuracy and Niceners, as to become on that very account the Objects of the Mathematicks? And yet we fee that they don't move one Point forwards without continually obeying the fame in their fo fwift a Courfe. And this Experience is even proper from whence to form fixed Rules in Gumery and Bombarding, whereby Bodies protruded with fo unexpreffible a Force, in a Courfe fo fwift, as hardly to be reftrained by any Powers, can be fo exactly determined and regulated by the Defign of Men, who have fudied the Laws to which they are Subject, as to be made to fall upon, or ftrike any particular Place, provided the fame be within their reach.

Sect. XII. The Operations of Gravity in the Catenaria or Chain-Curve.

We could here produce numberlefs Cafes in which it may be proved, that not only thofe prodigious flying Globes, fuch as Cannon-Bullets and Bombs, of which we have already fpoken, but likewife thoufands of Millions of others, and of the fmalleft Bodies, do defrribe Geometrical CurveLines, wherein the Property of the Line, according to all the Laws of Mathematicks, is preferved in all its Points. Thus there run many thoufands of Water-Particles out of the fpouting Pipe of a Fountain, and not one of 'em fhall tranfgrefs the

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Line which the Mathematician can fhew that it ought to defcribe in thofe Circumftances. What Honour did that great Mathematician Leibnitz acquire, by flewing that he had attain'd to a perfect Knowledge of the Curve-Line A C B, Tab. XXIV. Fig. 3. which is produced by the Gravity of the Parts of a Chain or Rope, faften'd to two Nails A B ? And how much Efteem and Credit has it given to Dr. Gregory, to have been the firt Difcoverer of fome new Properties of the fame? How many Mathematicians have in vain turned all the Powers of their Mind towards thefe Difcoveries, who notwithftanding that they fufficiently knew the Properties of Gravity, which was the only true Caufe thereof; yet are forced to own, that they were unable to defcribe rightly upon Paper the Catenaria or Chain-Line, for fo the abovefaid Curve is named? And who can contemplate without Aftonifhment, how nimbly the ignorant Parts of which this little Chain confifts, do difpofe themfelves by their Gravity into that Order, which is requifite to produce the fame? And thus we might give many more Examples of the fame Nature.

Sect. XIII. There can be no Ignorant Neceffary Firft Caufe deduced from a Series of Ignorant Caufes operating together.

IK no w very well, that thofe who fet themfelves as much as poffible againtt a Knowledge of God refulting from the Creatures, will anfwer, that thefe Laws of Nature, according to which all thefe Things happen, and this Difpofition of the Parts of the Catenaria, this Motion of Foun-tain-Water in its Courfe and Line, this Direction of Bullets and Bombs in their Flight are always neceffa:
neceffary, and that it would be impoffible it flould happen otherwife; and this they maintain to be the Reafon that thofe Mathematicians who argue juftly, can draw Conclufions agreeing with the Premifes.

For Infance, 'it is known that there is a Law in Nature, that in cafe two Powers do equally act upon a Body A (Tab. XXIV. Fig. 4.) of which one acting in the Direction to A K , and the other according to AL, (and move the faid Body) that as the one or the other is more or lefs Violent, that Body will be moved according to different Lines A D, A E, or A G, which are found and determined by drawing a Diagonal Line in the Parallelogram A B EF, A H GC, the Sides of which confift of the Lines along which the Body would be moved by each particular Power in the fame time, as here A B and AF, or A H and $A C$; from whence it then follows, that if in a Minute, or more or lefs time, the Body A fhould be moved by one Power from A to C, and by another Power from A to B ; that the fame Body A, by the Action of thefe two Powers, would equally in one Minute be protruded, according to the Line A P, the Length A D, which is the Diagonal of the Parallelogram A B C D.

But in cafe the Firf Power could move the fame not from A to C , but to F in one Minute; and the Second Power remained the fame, it might defribe the Line AE in a Minute: In the like manner alfo for the fame Reafon, if the Second Power that protrudes it towards A L were greater, and could carry the Body in a Minute from A to $H$, if the Firft remained unchangeable according to A C, by both the Powers together the Body A might in one Minute run the Space from A to $G$ along the Line A G.

From which Principles, Sir Ifanc Newton has fliewn briefly in his Princip. Philof. p. 14, and Mr. Varignon more largely in his Nouvelle Mechãnique, that all the Laws of Motion, and the Rules of Mechanics do neceffarily flow, and have given Inftances thereof in all the Mechanical Powers.

It is likewife known, that the Flight-Line of a Bullet difcharged from a Cannon, (Tab. XXIV. Fig. 5. A D E F G) is determined merely by this Law of Nature; forafmuch as there are every where two Powers àting upon it, viz. one, which being produced by the force of Gunpowder, does continually impell it from $A$ to $K$; and another, that of Gravity, which caufes it to defcend continually by the Lines AB, D L, EM, ©r. which are at Right Angles with the Horizon.

Sect. XIV. The Firf Motion proves a God; as does alfo the Continuation and Communication of Motion.

Since the Philofophers, whom we are endeavouring to convince, are wont to inquire into, and to prove the immediate Caufes of all Things from their Effeets or Operations only, why do they not more ferioully endeavour to afcend to the firft Caufe of all Things? They find that the moft, if not all the Appearances in Nature that have been hitherto known, are caufed and brought about by Motions; whether we may call them Protrufions, or (with fome other great Men of the prefent Age) Attrations or Repulfionis; they inquire what Laws of Motions muft follow from either Percuiffons or Attrcifion's: Now let them exrend their Studies to the Caufe that firft produced thefe Motions, and immediately the Power of a Deity will appear to them from Mathematical Conclufions, efpecially if shey will pleafe to Re- flect upon what Experience has taught them and all Mankind; namely,
I. That a Body may be put into Motion, and may likewife be at Reft, or ceafe from Motion; and that in both thofe Cafes it will remain a compleat Body, and preferve its Exiftence.
II. It follows from thence, that Motion does not belong to the Being of a Body.
III. Whereupon it may be here obferved, that the famous Sir Ifacc Newton, and the Commentator upon his Arguments and Demonftrations, Mr. Whifon in his Pralect. Phy. Defin. I. p. 25. (we Inftance in both thefe Gentlemen, becaufe no Body will difpute them the Title of very great Mathematicians) have rightly defcribed or defined a Body to be an extended and folid Subftance, not only indifferent to Motion and Reft, but likewife without any Power in it felf, and fimply Paffive (Subftantia Inersér Pa(fiva) of which Mr. Maria otte gives a Proof by feveral Experiments, in the Fifth Propofition of his Treatife about Percu(Jion, p. 3 I. thewing that how much more folid a Body is, that is tofay, how much more of Corporeal Matter it contains within the fame Space, fo much greater is the Reffiftance which it makes againft Motion.
IV. So that from all this it is eafie to conclude, that no fuch Thing as a Body can be the firft Caufe of thofe Motions, which neverthelefs we find to obtain among Bodies.

What can then follow, fave only that the firlt Caufe thereof mult be Incorporeal, and even wonderful and unconceivable in his Operations, forafmuch as not being a Body himfelf, he is able to move all Bodies.

Who is likewife the firf Caufe of every Thing that happens in the World, in which every Thing is performed by Motion; who is a Caufe working freely, and according to his own good Plea- on cannot be made without a Body, yet a Body exilting, it cannot be proved by any Confequence that it mult neceffarily move ; fo that if it be endowed with Motion, the fame muft be deduced from a Caufe operating without any Neceffity.

Now this Caufe muft be infinitely Powerful, to be able to frame an Edifice of fo vaft an Extent as the Univerfe is, and to move fuch mighty Bodies as the Planets with fogreat a Velocity as has been fhewn above; he muft likewife be infinitely Wife, fince he is able to direct the Motions of numberlefs great and fmall Bodies to fuch glorious Purpofes. This I think no Body who underftands what has been already faid can deny with more Reafon than he can ftifly maintain, that a Ship can fail without a Rudder; that a Watch can fhew the Hour without a Hand; that a Bell can found without a Clapper, and fo of many other Machines, that they are made without any Defign. Now in all Matters where we can difcover a determinate End and Purpofe, it muft be confelfed, that a wife and underftanding Being is concerned in the framing of them, fince nothing that has no Knowledge can propofe any End to it felf. Finally, this Caufe muft be infinitely good, fince by fuch Motion it imparts Life and Breath to all Animals, and beftows numberlefs other Benefits.

Befides all this, fince it is here fuppofed that we have to do not only with a Sceptical Philofopher, but likewife with a Mathematician too, and who confequently in order to fupport the preceding Objections, thinks himfelf capable to fhew how the Laws of Motion may by a perfect Neceffity be deduced from each other without any Divine Direction or Original ; we intreat this Difputer, that he would only recollect the firft
'Axiom, without which all Mathematical Argumentations would be in vain, and which therefore Mr. Whijfon terms the molt Fundamental of all; in his Pralect. Pbyf. Matbem. Axiom the 1.p.41, and which likewife Wallis in his Mechan. cap. 1. Prop. 11, I2. Huygens, Newtor, Keil and Mariotte (which laft has endeavourcd to render the fame more plain by a particular Experiment) and many others have laid down for the Foundation of Mechanics, it is briefly this:

A Body being once at Reft, or in Motion, ceafes not from that Reft, or from being moved in a Right Line with the fame Force, and without any Augmentation or Diminution thereof; unlefs another Force acting upon it produces a Change therein.

This is allowed by every one, when a Body is at Reft, but when in Motion 'tis doubted by many unexperienced Perfons; but fince our Philofopher is fuppofed to underftand Mechanics, he muft be likewife convinced of the Truth of this Law of Nature, fince a great Number of Experiments have been made in Machines to confirm the fame, by which this Law is with fufficient Certainty proved a Pofteriore. And it will plainly appear to him whom we fuppofe to have read the Writings of great Men, what Pains they. have taken in feeking after a fatisfactory Caufe of this wonderful Pbenomenon, which will therefore be unneceflary to mention here; and that fome of 'em have afferted in exprefs Words, that the Almighty God is the only Caufe thereof. See Keil's Introduct. p. 1 I 8.

And if he ftill retains his Doubts, let him confider the following Law of Nature, according to which it has been allowed and experienced by every Body, that the Motions, and all their Differences and Changes in all Bodies are greater and fmaller in Proportion, as the Powers which imprefs the fame into $t b 0 / 0$
thofe Bodies are greater or Simaller. According to this Argument produced by moft, that all Effects are proportionable to their adequate Caufes: See Wallis Mechan. cap. 1. Prop. 7. So that if one cerrain Force caufes one Motion, the fame being doubled will caufe a double Motion, a triple Force, a triple Motion, and fo on.

And let him fuppofe, that if a Man in the beginning of the World, or four or five hundred Years ago, had laid a little round Marble upon a Table, and to put the fame in Motion had given it a Fillip with his Finger ; the faid Marble, according to the abovemention'd Law of Nature, would (if no other Force had oppos'd its Motion) have moved to this very Minute with the fame Velocity in a Right-Line, and without ceafing, would have continued to run in the fame Line fuch a Length, as no Man could determine the end of.

He knows that this is no vain Opinion, but, as we have fully fhewn before, a Law of Nature realiy obtaining in moved Bodies, confirmed by very many Experiments, and upon which almoft the whole Science of Mechanics and Percuffions, particularly the Properties of accelerated and retarded Motion are founded; Examples of which may be met with in the Demonftrations of the two furf Propofitions of the Mechanics of Dr. Wallis.

And let him farther confider with himfelf, if no Divine and Incomprehenfible Power had place herein, which caufed the Continuation of this Motion, and which obliged all Bodies continually to obferve a Law, that otherwife was neither to be believed nor underfood; whether he could imagine that the fmall and contemptible Force communicated by the Fillip of a Finger, could be the adequate Caufe of fuch a Motion, by which this little Body can exceed in its Courfe all the Bounds

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Bounds that he or any Man living is capable of prefcribing to it, without any lofs of its Force and Velocity ; and whether any one befides himfelf would fay, that this fo great an Effect can be accounted proportionable to fo mean a Caufe as the Fillip of a Finger; and if this does not fatisfie him, if he be a Mathematician, he muft know firf, that no Body can be fo fmall, or move with fo little Force, but that ftriking againft another, (which is at Reft, and has no Obftruction) how great foever this laft may be, it will move it, and caule it to run forwards in a frait Line, fo that both of 'em will proceed with equal Swifnefs; tho fuch Swiftnefs will be fmaller than that which the firft moved Body was endowed with alone. (See beffides, concerning this Matter, Wallis his Mechanics, Ch. XI. in the Scholium, Sect. II.)

So that from hence it follows, that when a little Body, not fo big as a Marble, but fo fmall even as the fineft Grain of Sand, being protruded by the Fillip of a Finger, runs or ftrikes againft another Body, which we will fuppofe to be as big as the whole Globe of the Earth, or if you will, thoufands of times yet bigger (provided that neither of 'em be Elaftical, and confequently rebound from each other) this great Body will not only be protruded together with fuch a Grain of Sand according to a Right Line; but unlefs fome oppofing Force or Obftacle do intervene, and hinder the aforefaid Motion, the great Body, as well as the little Grain of Sand, will by the Force of this Fillip, continueto be moved according to the faid Line inceffantly; and if they were to meet in their Way with a hundred thoufand of other Bodies, and each of them were a Million of times bigger than the Earth, they would carry them all along with 'em in Confequence of this fmall

Force, without any ones being able to determine how far.
Now that this, how wonderful foever it appears, is certainly true, no Mathematician can deny; but let this Sceptical Philofopher, who hopes by the neceffiary Deductions of one Law of Nature from another, to elude the Providence and Intervention of a God; I fay, let, him fhew us from his Principles, whether he can any ways comprehend, not that fuch a Thing actually happens (for this the Mathematics will teach him) but how, and after what manner this Force of a little Grain of Sand fo moved does att ; fo that any Percurfion thereof does not only protrude fuch unconceivable great Bodies with any Force, but likewife can continue the Motion of them without ceafing for thoufands of Ages: And it has been long a queftion in Phyficks, How the Motion of one Body is communicated or transferr'd to another? which as far as 1 know, has never yet been rightly anfwered by any.
Then in cafe he could make no other Reply thereto, than that both the Communication and Continuation of Motion, is fomething which indeed he fees daily happening, and in the fame Cafes ; but that yet the moft internal Effence of Motion is not fo well known to him, as that he fhould be able to lay, after what manner it paffes from one Body to another ; and notwithfanding what is accounred the vifible Caure (as the Fillip, which in this Inftance produced fuch a Motion in the Sand) has long ceafed to exift ; yet the Effect may Iaft not only in its Form or Being, but likewife in the fame Force, fuch a Number of Years as no Man is able to determine; for to fhew the Greatncfs thereof, it is well known to thofe that underfand Mathematicks, that according to this Law, a fix and thirty Pounder being protruded out of a Cannon by the Force of the Gunpowder inflamed, would continue its Motion with the fame Strength and Swifnefs for thoufands of Years, unlefs hinder'd by fome other Force, notwithftanding that the Flame of the Gunpowder had ceafed long before : Will he not then even by this his own Anfwer be compelled to acknowledge, that here, as before in the Motion of the Body itfelf, there is likewife an incomprehenfible Power operating in the Communication and Continuation thereof ?

SEct. XV. The Reafons produced by fome for the Continuation of Motion, feems too weak.

I Know very well, that fome great Mathematicians who even confefs that they can fhew no Caufe of this laft Phxnomenon of Divine Power, which maintains every Thing in its Exiftence, and by Confequence likewife this Motion of a Bullet in its Continuation, to Illuftrate the Matter, affirm, that a Bullet being once put into. Motion will always remain fo; juft as a Square, and a Globular Body will always retain the fame Figure'; but I hope I fhall be excufed by them, if notwithftanding all the Efteem which I have for their Learning, I here add, that this Comparifon, tho' produced with the beft Defign, which is to acknowledge God for the Caufe, feems to me fomewhat too weak, and not fufficiently Analogous and Proper : Since, Fir $f$ t, tho' a Body being once turned from a Square into a Globular Figure, tho' it remains of itfelf Globular, yet the lafting Operation of the Globular Force does entirely ceafe: Whereas on the contrary, a Body that was once Still, and at Reft, being put into Motion, the lating Operation of fuch moving Force will fully remain. Secondly, Since a Body cannot move of it felf, being according to the Defcription of thofe

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thofe Gentlemen a Juggijb Lump of Matter, and all Motion feems to require a Force which continually produces it; forafmuch as we fee fuch dreadful Strength and Violence exerted by a Body once moved (as for Inftance, by a Bullet fhot out of a Cannon) which whilft it remained motionlefs, could not exert the leaft Force : So it feems to be a neceffary Confequence, that a Body that has continued already a thoufand Years in Motion, fhould not retain the fame Motion for a thoufand Years following, without a Power acting upon it, and producing farther Motion; whereas in order to retain a Circular Figure, there feems no farther Force to be neceffary, than that a Body fhould at firft affume fuch a Figure.

Nor is this oppofed by any Mechanical Experiments or Rules; by which it plainly appears, that one Body running againft and ftriking upon another, which other is at Reft, both of ' em will continue moving with equal Swiftnefs in a Right Line, till fome other Power fhall caufe a change therein ; but it is not maintained nor demonftrated, that with the Continuation of this Motion the Power that protruded the Body, does not remain conftantly acting.

Now which foever of thefe be true, it is fure enough; I. That this Communication and Continuation of Motion are both obfcure and entirely unconceivable, as to the manner of their Production. 2. That they are the Foundation of every Thing we are taught in Mechanics, and of all that happens in the World ; infomuch, that nothing can fcarce appear plain either in Mechanics or Phyfics, to fuch who have not inquired into the Laws thereof.

SECT. XVI. GOD atts Reafonably, Incomprebenfilly, and according to bis own good Pleafure.
I Leave it now to the Judgment of an Atheift himfelf, whether he mult not confels and allow ;

1. That there is a Power acting in Nature after a manner not to be comprehended by him, tho' the Effects are obvious to every one.
II. Whether all Things are not brought about in the fuppofed Cafes by meer natural and ignorant Bodies, according to the moft fecret Methods of the Mathematicks.
III. And confequently, whether there does not then appear a Power in this Univerfe, which acts not only Incomprehenfibly, but likewife Rationally, that is to fay,according to Laws reducible to right Reafon, or otherwife in fhorter Words, whether he cannot difcover a God in all thefe Things; who to the end, that he may be found not only by thofe that feek him in his Works, but likewife by fceptical and irreligious Philofophers too, has impreffed clear and manifeft Tokens of his Incomprehenfibility, and confequently of his Greatnefs upon the Origin of Phyfics, and the very Laws of Nature; to the end that an Inquirer into the Knowledge of Nature, how diligent and penetrating foever he may be in many Matters, yet if he be carelefs in this one great Point, may, before he proceeds any farther, be armed againft this Temptation that has caufed fo many to wander and depart from true Knowledge and Wifdom; forafmuch, as becaufe they obferved the Neceffity of Mathematical Confequences, and likewife that natural Things do always really adapt themfelves according to the fame, they therefore began to imagine, thatall Things come
ceeds to prefs with fo much Violence, according to the fame Right Line or Direction, that we fee thereby great Bulwarks, Walls, and the like, overturned thereby; and tho' as many Caufes thereof fhould be alledged, as there are particular Hypothefes, who can prove, that the faid Caufes do neceffarily refult from the Nature of Bodies?

So that if indeed we could continually and properly trace them back from Caufe to Caufe, we fhould unqueftionably find, that the firft, which is the Spring of all the reft, acts without any Neceffity, both as to the things themfelves, as alfo to the Manner thereof.

For which Reafon, the Wifdom that appears in thefe Operations, and the Power being joined together, we need not fearch any farther for a Great, Glorious, and Adorable God; who to the End that every Body might be convinced that the true Original of all things which happen in Nature, is only to be deduced from his infinite Perfections, has depofited, and does ftill preferve the undeniable Proofs thereof, in the firft Natural Principles of all things.

Sect. XVIII. The Proof of a God from the Motions of the Particles of Light.

But to turn into the Way again from this Digreffion, which yet was, in fome manner, neceffary to convince fome unhappy Mathematicians, not fo much of their prepofterous Ways, as of their Neglect and Omiffion in jufly difputing concerning the firt Caufe of all things; let us then pafs on to other Matters, and produce one Proof, which will appear undeniable to all reafonable Perfons, of a God directing every thing even to the fmalleft Particles and Atoms, as we fhall fhew. from the Motion of the fame.

How many Millions of Millions of the Particles of Light do iffue, in one Inftant, from the Flame of a Candle? How much, yea, how unconceivably fwifter are they than a Cannon-Bullet? Concerning which the Reader may confult the XXIV and XXV Contemplations, and if we would fee how exactly they obey the Rules prefcribed to them, in all their Number and Velocity, let us fuppofe the Flame of a Candle at A B (Tab.XXIV. Fig. 6.) and hold with one Hand a common Spectacle-Glafs at G L, at a pretty good Diftance from the Candle, and with the other Hand a white Paper at $f b$, juft behind the Glafs, which being carried backwards to e $d$, you will meet with a Place as $a b$, where you will fee the Light which at firft appear'd confufedly upon $f b$, reprefenting perfectly and diftinctly the Flame of a Candle inverted.

Now we know that this exact inverted Pifture at $a b$, is occafioned no otherwife than that the Rays coming from the Point A, and making the Cone AGL, after having paffed through the Glafs G L, are all collected at the Point $a$, as thofe from the Point B at $b$, from C at $c$, and fo thofe that come from all the Points of the Flame are all collected in fo many Pointsupon the Paper at $a b$, and there crofs each other; for which Reafon the Pictures or Images, at $f b$ and $d e$, remain wholly confufed; becaufe the Rays coming from a Point of the Candle as A, upon that Place, do fill a large Space, and are mixed with one another, as has been fhewn before.

This being done, and the Courfe of the Light undertood, let any Man whatever caft his Eyes upon this Figure, and obletve in what a valt Number the Particles of Light run, and are mingledwith each other, juft before the Glafs; fo that all the Cones of Rays GAL, GBL, GCI, Kkk 2 and

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any one holds a Glafs betwcen the Candle A B, and the Paper $a b$, tho' they themfelves are not only entirely ignorant of any fuch Law, but likewife of their own Motions and Croffings; let him feriounly reflect, whether thofe Principles upon which he founds his unhappy Philofophy, can prove to his Satisfaction, that this does happen without the Direction of an Omniprefent Power, extending its Care over all things, even the fmalleft of Bodies.

Let him confider after all this, whether he cannot difcover a God herein, who to the End that thofe that defpife and deny him fhould remain inexcufable (at leaft all fuch as underftand the Motions of Light) has been pleafed that they fhall never open their Eyes without meeting and receiving an irrefragable Proof of a Wonderworking Deity, which fo directs and regulates the unconceivable Multitude of all the Rays of Light flowing from all Parts, and mingling among each other, and feeming capable of producing nothing but an irretrievable Confufion before the $\mathrm{Pu}-$ pil of his Eye, as it was before the above-mention'd Glafs, I fay, does fo regulate them all, that they can ferve for a diftinct Sight to all Creatures.

Sect. XIX. The Exifence of a God proved likewife from the Laws of Mechanifm in general.

Moreover, all who underftand Mechanics, or the Science of Motion, know that the fame in its greateft Extent, does confift of nothing elfe than Confequences that are deducible by Argumentation from fome few natural Laws; and that Bodies wholly ignorant of what they are doing, obferve the fame in all Circumftances with the utmof Exactnefs, even fofar, that before they depart from the fame, they operate things which to Kkk 3

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many Men that have not feen them feem incredible, and to thofe that have feen them, wonderful; Numbers whereof are to be met with in the Booksthat go under the Name of Natural MagicBooks, and Mathematical-Recreations; but fince we don't write here only for Mathematicians, we fhall not produce any Particulars thereof, but only ask thofe who fill doubt, whether upon their Reading a Book of any learned Author, in which are contained the Principles of Mechanics, (for Inftance, that of Stevin, Wallis, la Hire, and others, who have writ particularly upon that Subjeet) tho' fuch a Book confifts of Paper, Ink, and other Materials, in which there is neither Senfe nor Knowledge, yet they will pronounce, with grear Affurance, that it muft have been writ by fomebody who was Wife and Learned, and that underfood all thefe natural Laws and their Confequence.
$\mathrm{S}_{\mathrm{z}} \mathrm{ct}$. XX. Tranfition to fome Hydrofatical Laws.
Besides, the Laws by which the great Director regulates the Motions ofSolid Bodies, there are others that have place in Fluid Matters, and which if they do not very much differ, even in the firft Fundamentals, yet do they fo at leaft in the Phrnomena, or Appearances, refulting from thence.

Now fince we know, Firft, that the greateft Part of the Univerfe confifts of Fluid Matters, fuch as Water, Air, Light, ©cc. Secondly, That all the $e$ Fluid Matters are heavy, and confequently produce many things according to the Laws of their Gravity. Thirdly, That thefe Fluid Matters are the principal Inftruments of which the Director of all things does moftly make ufe. Foorrthly, Since in this Operation of Fluid Mat-
ters, the Wifdom, Power, and free Pleafure of the Creator of the World does fhine out after the cleareft manner :

We have drawn up a fhort experimental Demonftration of fome of the faid Laws of Hydrofaticks, to the end that when we proceed to Speak of the Law of Preffure according to the Depth, which has Place in Fluid Matters, and from thence deduce fo many Wonders of the great Ruler of Nature, any one may be entirely convinced of the Certainty thereof; which Demonftrations, thofe Readers, who think they ftand in no need of fuch Affiftances, may pals by, and go on to what follows them.

Experimental DEMONSTRATIONS of the Law of the Prefure of FLUIDS, according to their Heighth or Depth.

Sect. XXI. General Terms and Pofitions in Hydroftatics.

To begin then:
I. As to the Terms of Liquids or Fluids, we mean here the fame thing by them, tho' fome do not allow all Fluid Matters to be properly Liquid. For according to them, the Air is indeed a Fluid Matter, but not Liquid, as Water, Oyl, and the like; but for Brevity fake, we fhall make no Difference.
II. All the Parts of a Fluid, when at Reft in a Veffel which is immoveable, do yield to the fmalleft Force acting on them; and fo yielding, have their Parts eafily feparated, which immediately by their Gravity do again come together. The Proof of which is obvious to every Man's Experience.

HII. THE
III. The Superficies of ail Fluids, upon which there is immediately incumbent either another Fluid Subftance, or nothing elfe that is heavy, or that operates by another Power, will, according to the Action of Gravity, become Horizontal or Level, that is, fettle itfelf parallel to the Horizon.

In order to fee fuch an Horizontal Superficies (which may alfo tend to make us the more eafily apprehend fome of the following Terms and Expreffions) we need only pour into a pretty large Glafs, firft fome Water, and then fome Oyl of Turpentine, for the Purpofe; by which Means the Superficies of the Oyl, and the Separation of thofe two Liquors, will fhew the aforefaid Horizontal Plane, and the like will be obvious in almoft all other Liquids that are unmixable.

We fhall not here inquire whether the Superficies of a Stagnating Liquor be not likewife part of the Convex Superficies of the Globe of the Earth; but it is fure enough, that it may be fuppos'd, without Miftake, that it does not differ vifibly from a Horizontal Plane in fo fmall a Space as we are treating of.
IV. I add moreover, that we do not here pretend, with fome Mathematicians, to demonftrate every thing from Mechanical Principles; but only to fhow Experimentally the Action of Preflure or Gravitation of Fluids, as they are govern'd by the aforefaid Laws of Preffure according to their Height or Depth, that we may render them plain and intelligible to every body, and even to fuch as are not converfant in Mathematicks.
$\mathrm{S}_{\mathrm{ect}}$. XXII. The Order of the Experiments that are to be made for the Foundation of Hydroftatical Laws.

To proceed now, after premifing thefe things, to the Law itfelf of the Preffure according to Height, we can perhaps do nothing better in order to be more plainly undertood, and to give a true Conception of our Meaning, even to the mof Ignorant, than to fet before the Reader a few eafy and not coftly Experiments; for which Purpofe I fhall relate them juft as they ftand upon my Notes, taken about 16 or 17 Years ago, and in the fame Order too, namely, That the firft Experiments are made by one only Liquor, not fo much becaufe it is the ufual Manner in which Philofophers treat thefe Hydroftatical Subjects, nor becaufe Water, which is the Fluid commonly made ufe for thefe Purpofes, has no other Fluid Matter over, or above it, fince Air is always above, and preffes upon it ; but merely becaufe thefe Demonftrations are more fimple, and therefore more plain to Beginners, and that becaufe the Air gravitating with equal Force upon equal Parts of the Superficies of Water, this $\mathrm{Li}-$ quor may be much more conveniently ufed and obferv'd, than if any other Fluid Matter were incumbent on it.

The fecond Sorts of Experiments do herein differ from the former, that they reprefent to us the Action of feveral Fluids upon one another.

Sect. XXIII. of Fluids in Curve Tubes of equa Bignefs.

But before we enter upon thefe Experiments we thall premife what, among other things, ha: been firft found to happen in Curve Tubes o an equal Bore.

To wit, That in order to caufe a Fluid Mat ter in the Curve Tube A I D, (Tab. XXV. Fig.I. to quiefce or ftop at the Height A B in the Sidi A I, and to hinder it from defcending on accoun of its Gravity, you muft fill the other Side I D with the fame kind of Fluid, up to the lik Height. This is plain enough in itfeif, and the Experiment may be eafily made.

Sect. XXIV. An Experiment to Bow the greas Force of the Gravitating Power of Water.

The firf Experiment which was about thr Gravitation of Water, was the following :
I. I put into a large Glafs Veffel A B C D (Tab. XXV. Fig. 2.) a Curve Tube Y X Q, anc a ftreight one $\mathbf{Z} t$, after tying them in fuch a manner to a Piece of Wood that lay a-crofs ol horizontally upon the Rim of the Glafs, not only as to make Right Angles, but likewife that thei: loweft Orifices, P Q and $r t$, which were of equa Bignefs, were equally deep, that is, ftood ir: the fame Horizontal Plane L M.

Then pouring Water into the Veffel as high a: to $a b$, we might perceive the Water in bott the Tubes to rife up to $d e$ and $n m$; and as fat as it appeared to us, it afcended as high in the Tubes (which were chofen large for that Purpofe, as it did in the External Veffel.
II. Now forafmuch as the Water could not of itfelf rife as high as $d e$ in the Curve Tube YXQ, nor remain fufpended there unlefs a Force prefs'd it down at P Q, as appeared, becaufe upon ftopping the faid Tube with one's Finger at $Y$, and lifting it out of the Water in the Veffel by the Piece of Wood E F, if we removed the Finger from Y, we faw that the Water did not only not remain at $d e$, but fubfided to $u w$, driving out that which food in its Way at the Orifice P Q.
III. From whence therefore it was obvious, that whillt the Tube was in the Water, a Gravitating Power acted upon the Part P Q of the Horizontal Plane L M.
IV. Now to inquire into the Properties of this perpendicularly Gravitating Force :

It appear'd, Fir $t$, that the Force which prefs'd the Part P Q of the Horizontal Plane L M, did by no Means regulate itfelf according to the Surface or Breadth of the Water $a b$, nor yet to the Quantity of the whole Mafs of Water ab L M, which was incumbing upon the Horizontal Plane L M, of which P Q was a Part ; of this we affured ourfelves by putting the Tube Y X Q as low as $d e$, in a much larger Veffel ; for inftance, in a Bucket or Tub; in which Cafe we found, that notwithftanding the greater Breadth when the fame Depth of Water was incumbing upon $\mathrm{P} \mathbf{Q}$; yet the Preffure upon the Part $P Q$ was not greater, fince it could not caule the Water in the Tube to rife higher than to $d e$.
V. It appear'd, Secondly, that this Gravitating Force upon PQ, adapted itfelf mont nicely and
exactly
exactly to the Depth of the Water $a \mathrm{~L}$, which was the Column of Water incumbing upon $\mathrm{P} \mathbf{Q}$ and $\mathrm{L} M$.

For pouring gently fome Water into the Veffel, till it afcended on the outfide of the Tube to A $B$, we likewife obferved the Water within the Tube, to rife from $d e$ to R S.

But on the contrary, when by fucking or letting out fome of the Water out of the Veffel, it was reduced to the Depth of $a b$ or lower, the internal Water did alfo fubfide to de or yet lower, but fo as always to continue of the fame Height with the External.
VI. Now it has been fhewn before, and it alfo follows from Sect. XXXIV. that if the Curve Tube YX Q were extended from PQ to NO, or higher, and then fill'd up to the Height of $g b$ or $a b$ of the Veffel, the Preflure of this Column of Water PQhg would be great enough to fuftain the Water in the other Shank of the Tube to $d e$.
VII. So that we may conclude from hence, that the whole Mafs of Water in the great Veffel $a$ L M $b$, gravitates as much, but neither more nor lefs, upon P Q , than this fame Column of Water P Qbg.
VIII. Now fince this Column $P Q h g$, is equal to a Column whofe Bafis was the Part PQ of the Horizontal Plane L M, and whofe Height is the perpendicular Height $\mathrm{P} g$ or $Q b$ (or otherwife $\mathrm{L} a$ or $\mathrm{M} b$ ) or the Water incumbing from $a b$ upon the Horizontal Plane L M: A famous Propofition in Hydroftaticks is deducible from hence, namely, That if we fuppofe a Horizontal Plane paffing thro' a ftagnating or quiefcent Fluid, the Force whereby a Part there of
thereof, as PQ , is gravitated upon, or prefs'd down, is equal to the Weight of the aforefaid Column P Qgh, whofe Bafis is the Area of P Q Part of the Horizontal Plane LM, and the Height of which is $a \mathrm{~L}$, or $\mathrm{M} b$, or the whole Height of the Fluid imcumbent upon the faid Horizontal Plane, meafuring the fame directly upwards.
IX. This Column (becaufe it extends itfelf from the fuppos'd Horizontal Plane to the uppermoft Superficies of this fingle Fluid, and, if there be more Fluids imcumbent on each other, to the uppermoft Superficies of that Fluid which is higheft, and contains all the perpendicular Heights of all the Fluid Matters impreffing or incumbing on each other) we fhall hereafter, for Brevity fake, call the Column of Altitude.
X. Now to fhew that there happens not only to this one, but to all equal Parts, as P Q , of the fame Horizontal Plane L M, one and the fame Preflure, and each equal to the Weight of this Column, we remov'd the little Piece of Wood E T, with the Curve Tube Y X Q that was tied to it, from one Part of the Veffel to the other, fo that the Orifice $P Q$ fill'd at every Turn a new Place of the faid Horizontal Plane, but we always found the Water fropping at $d e$, or at the fame Height; and confequentiy that every Part equal to the Area P Q of a Horizontal Plane L M, is always prefs'd down with an equal Force, which is alfo equal to that of the Column of Height.
XI. And to fhew farther, that the different Figures of Veffels did not alter the Cafe, or that it is not neceffary that this gravitating Column PQbg, fhould be always direetly perpendicular to the Part P Q that it preffes, we thruft a

Piece of Wood I K, G H, with a flat Bottom G H, or a Beer-Glafs, or a Phial with the Bottom downwards, to a certain Depth as G H, under the Superficies of the Water $a b$, and held it there immoveable; after which we turn'd the Tube Y X Q quite about, bringing the Orifice $\mathbf{P} \mathbf{Q}$ to $p q$ directly under the aforefaid Bottom, and we obferv'd, that notwithfanding the gravitating perpendicular Column over $p q$, could not extend itfelf higher than to G H, yet the Water remain'd in the Tube at $d e$, and confequently at the fame Height, as if the whole Column of Altitude PQhg, were fupported or refted on PQ:
XII. So that it appear'd from thence, that each Part P Q, $p q$, \&c. of the Horizontal Plane L M, was not always juft prefs'd by the Column of Altitude itfelf, but by a Weight equal to that of the faid Column; and confequently that this Law obtains in Veffels of all Figures, of which, tho' there be here but one fingle Inftance given, and numberlefs Veffels might be propos'd for Tryal, fufficiently confirms our Pofition with the Concurrence of all that are vers'd in Hydrofaticks, and abundance of Experiments in all kinds of Veffels.
XIII. I muft however endeavour to remove one Difficulty, which it may be renders what we have juft now faid obfcure to fome People, and then pafs on to fome what elfe.
It is this, If a Drinking-Glafs or Cup $k l 7,8$, be filled with Water, and then inverted fuddenly, fo that the Mouth 7,8, defcends below the Superficies $a b$; and if one continue the Cup or Glafs in the faid Pofture, it will be found :

Firf, That the Water will defcend either to $k \mathrm{~L}$ or $c f$, according as there was more or lefs of it in the Glafs, but by no Means fo low as 9 or 10 , or as the external Water $a b$.

Secondly, That in cafe the Curve Tube Y X Q , in which the Water is at the Height of $d e$, be turn'd about in its String and fhov'd forwards, if neceffary, with the Piece of Wood E F, fo that the faid Tube Y X Q be brought to I 46 and its Orifice $P . Q$ to 56 directly under the Glafs $k l 78$ (continuing fill in the Horizontal Plane L M) we fhall find that the Water will remain in the faid Tube immoveably at 23 , the fame Height as $d e$, and as the external Water $a b$.

Now fince each part PQ and 56 of the Horizontal Plane L M is prefs'd by the Column, the Height of which is equal to the Height of the Water, and forafmuch as there is no more Weight upon $P Q$ than the Column $P Q g h$, and fince there feems to be incumbing on 56 a Gravitating Column s $6, f c$, of a greater Depth, and confequently of a greater Weight than that of PQhg; it feems that it ought to follow likewife, that the Preflure upon 56 fhould be much greater than that upon PQ ; and therefore that the Water in the Tube at I 46 fhould afcend much higher than 23 or $d e$, but on the contrary, the Water at 23 or $d e$ continues at an equal Height with the external $a b$.

This Experiment would be a notable Objection againft what we have advanced, were it not that all who are any ways vers'd in Hydroftatics, know, that what is faid before; is only meant when there is no other gravitating Fluid upon the Water $a b$; and that the Preffure of the Air, which always gravitates upon the Water $a b$, is only the Caufe here that the Water continues fuspended in the Glafs or Cup at $c f$. That in ter in the faid Glafs $k l 87$ would not continue higher than the external Water $a b$ or $9 \mathbf{1 0}$, tho' the Glafs be inverted; as is well known to thofe that ufe Air-Pumps.

So that this Objection is properly of no weight againft what we have afferted, fince we only treat of Cafes in which the Preflure of the Air produces no remarkable Alterations, or at leaft, in which we may fuppofe them.

Sect. XXV. Experiments proving that Fluids prefs upwards.
XIV. T o proceed now to the Preflure of Fluids upwards:

That in Water and other Fluids a Preffure upwards has likewife Place, may be inferr'd from many Water-Works and Fountains that throw up Water.

This will alfo appear by the ftrait Tube $\mathrm{Z}_{r t}$ : For unlefs the Water at the Pare $r t$ of the Horizontal Plane L M were prefs'd upwards, it would not be poffible that the Column $r t n m$, which lies upon the Superficies of the External Water $a b$ in the Veffel, could keep its Station at $n \mathrm{~m}$, fince it is continually prefs'd downwards by its own Weight.

To give then an Inftance thereof: Stop the empty Tube $\mathrm{Z}_{r t}$ with your Finger at Z , and thruft or put it down into the Water as far as $r t$, you will thereupon find that the faid Tube will remain empty from Z to $t$ or thereabouts; excepting perhaps, that by the Preffure upwards of $r t$, the Water may rife a little, or fo much higher in the Tube than $r t$ (if let down into a great Depth where the Preffure upwards is Atronger) as
the Force of the faid Preffure can contract or fqueeze together the Air which is in the Tube.

But in order to know with what Force $r t$ is preffed upwards, you need only remove your Finger away from $z$ the Orifice of the Tube, and fo give a free Paffage to the internal Air which is driven againlt the Finger by the preffure of the Water from below, and you will find (in cafe the external Water be as high as $a b$, and the Tube be tolerably large, fo that there be not too great an adherence of the Particles of the Water to the fides of the Tube, on account of its narrownefs) 1 fay, you will find that the internal Water will not only rife as high as the external Surface $a b$ or $n m$, but much higher at firft, for Inftance, up to TV; and that it will afterwards fall down from thence below $n m$, and not till after fome Vibrations up and down, continue at $n \mathrm{~m}$.

From which Motion, or Afcent and Defcent of the Water in the Tube $\mathrm{Z}_{r}$, it is plain that it is not only hinder'd by a Refiftance from falling down, as if it were oppos'd by a folid Body at $r t$; but that a real and actual Power obtains here, and operates like Weights in the Scales of a Balance, which do likewife fluctuate or dance up and down, before they arrive at a juft Equilibrium.

Finally, this Force preffing upwards, feems to be fully proved by the following Experiments.

Take a crooked Tin Tube (Tab. XXVI. Fig. I.) A D F, which is of fuch width at EF, as to be exactly cover'd with the Top or Lid of a little wooden Box E G HF. Put it down into a Veffel N T CO fill'd with Water up to the Surface NO, and you fhall find that the little Lid * EGHF, tho much lighter than the Water,

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will

[^3]will fubfide like a Stone, and how deep foever it be placed in the Water, will remain immovable on the Orifice EF of the faid Tube, until the Water infinuating itfelf between the Lid and the Tube, raifes it felf upwards, or till filling the Tube to $1,2,3,4$, the Air at 3,4 E F, raifes up the faid Lid.

Hence it is plain, that if a lighter Body than Water (for Inftance, fo thin a Subftance as this little piece of Wood) is not rais'd by a real Force preffing upruards, that it will by no means float, but fubfide like heavier Bodies. We fhall fhow hereafter, that Water can even raife and caufe Lead to float by the like Force; but what we have advanced, is fufficiently confirm'd by the prefent Experiments.

Sect. XXVI. An Experiment to Shew the Greatnefs of this upward-preffing Force.
XV. From this Warer fufpended in the Tube Zrt (Tab. XXV. Fig. 2.) we may judge Firft of the Greatnefs of the upward-preffing Force, at $r t$ for Inftance; for fince there is one Force acting by an upward Preffure, and another by a downward Preflure upon $r t$, as has been prov'd before, it is plain, if the Fluid at $r t$ does neither afcend nor defcend, but remains at the fame Point, thofe two Forces or Powers muft be equal to each other; for if either prevail'd, the Water at $r t$ would be moved according to the Direction of that Power.

Now fince $r t$ is preft downwards by the Column of Altitude $n m r t$, as is fhewn before; it is plain that $r t$ is alfo preft upwards by a Force equal to the Weight of this Column of Altitude.

This may be proved by a ftill different Manner.

Take a Tube, which for Convenience fake frould not be too large, and thruft it down into the Water as far as 11, 12, $r t$ : Stop the Mouth of it with your Finger at $Z$; then if you lift it up perpendicularly out of the Water, the inclos'd Fluid will remain fufpended at $1 \mathrm{I}, 12, r t$, as is known to thofe who try Wines; then put the faid Tube again into the Veffel fill'd with Water up to $a b$, fo as the internal Water II, I2, may be below the Surface of the external $a b$ or $n m$, or elfe above the fame.

If then you remove your Finger from $Z$, you will fee in the firft place, that the Force which preffes $r t$ upwards, is greater than the Weight of the Column $r t$ II, 12; and that it will caufe the Fiuid to rife from II, 12 to $n m$, or to an Height equal to the external Water $a b$.

On the contrary, if you take away your Finger from Z, when the Fluid $1112 r t$ is up at TV or higher than the Water $a b$, you will find that Upward-preffing Force at $r t$, is lefs than that of the Column of Water $r t \mathrm{TV}$, and confequently that the faid Column will defcend notwithftanding the Force which preffes upwards, as low as $n m$, or a $b$.

Only if you thruft down the Tube with the included Water fufpended for the Purpofe at $n \mathrm{~m}$, till the faid $n \mathrm{~m}$ be parallel with the horizontal Plane $a b$, or till the internal Water $n m$ be of an equal Height with the external $a b$; you will fee, that upon removing your Finger, the Water in $r \pm m n$, will remain there without rifing or falling.

From whence it may be inferr'd, that the Forces which preft upwards and downwards, are in this Cale equal to each other; and therefore that a Altitude $r t n m$, is likewife preft upwards in Stagnating Fluids, with a Force equal to the Weight of the faid Column.
XVI. If now, upon removing the Tube $\mathrm{Z}_{r t}$ faften'd to the little Piece of Wood E F, and carrying it along all the Parts of the Horizontal Plane L M, the Water remains continually Surpended in the Tube at $n m$; it follows, that every Part of the faid Plane equal to the Orifice $r t$, is preft upwards with an equal Force.
XVII. Now that this Upward-preffing Force adapts itfelf exactly to the Depth, but by no means to the Breadth, nor to the Quantity of the Warer ftanding above a Horizontal Plane, may be fhown here, as it was before, by the Force that preffes downwards. For if yox pour Water into the Veffel till it afcends from $a b$ to A B, the upward Prefliure will be proportionably greater at $r t$, and caufe the Fluid in the Tube to rife from $n m$ to TV.

But if afterwards you draw off fo much of the Water in the grear Veffel, as to bring it down from AB to $a b$, or lower, the upward preffing Force will proportionably leffen ; and whereas it was able before to raife the Internal Fluids as high as'TV, it can't now keep it up beyond $n m$.

Thus we fee every Thing adapts itfelf to the Heighth or Depth.

And if you have a mind to make this Experiment with a Bucket or Tub of Water, or with any orher Veffiel greater or fmaller than that we ufed, you will find that the Breadth or Surface ofthe Water makes no Alteration, nor will the upward preffing Force produce any greater or leffer Effect

Effect, than to continue the Fiuid $n m$ in the Tube furpended at the Height $a b$ of the external Water.

Sect. XXVII. The Laws of Prefure up and downwards.
XVIII. $F_{R ~ o m}$ all this it is eafie to conclude, with Refpect to the upward and downward Preffure compared together, that,

If we fuppofe a ftagnating Fluid (Tab. XXV. Fig. 2.) a Horizontal Plane from $L$ to $M$, a Number of equal Partstaken at Pleafure, fuch as $P$ Q $r t, p q, n m, 56, \notin c$. each of thefe Parts.

Being Firft prefs'd upwards with an equal Force :

And Secondly, downwards, with one and the fame Force as another, be it what it will.

Thirdly, (and which is of great Ule in Hydrow fatics) that one Part, as P Q, taken at Pleafure, is prefs'd with as much Force downwards, as another that is equal to it, as $p q, r t$, $\dot{\sigma} c$. likewife taken at Pleafure, is prefs'd upwards.

And alfo on the contrary;
That the firf Part P Q, is prefs'd with as great a Force upwards, as $p q$, or $r t$ are prefs'd downwards.

Fourthly, That the Force which preffes each Part upon the other, is equal to the Weight of the perpendicular Column of the Fluid.

All which is plain enough from the foregoing.

Sect. XXVIII. An Experiment of the Downward Preffure of different Fluids upon one another.
XIX. Hitherto, like many others, who write about Hydroftatics, we have only confider'd L113

Water

Water as a Fluid that has no other upon or over it. But forafmuch as there is another fluid Matter which is ufually incumbent on it, namely the Air, and which in fome Cafes does often and notably exert its Power, as we have fhown above, Sect. XIII; it will not perhaps be difpleafing to fuch as have not been much converfant in Hydrofatics, if we fhould here confider fome of the Properties of different Fluids lying upon each other.

The Experiment therefore which we made fome Years ago for this Purpofe, may be perform'd with all unmixable Liquors; as thefe two are in which we fee Brandy that has ftood a while upon Pot-Afhes, to which we may joyn Oil of Turpentine for a third unmixable Fluid. We only try'd the fame with two, to wit, with Pickle or Water, in which there was as much common Salt diffolv'd as could be, and with Oil of Turpentine.

We therefore took two little Sticks $c d$, and ef, and bound them to a Piece of Wood $g h$ (Tab. XXV. Fig. 3.) which, as in the foregoing Experiment, we placed upon the Horizontal Rim of a pretty large and deep Glafs-Veffel, fo that the faid Sticks made right Angles with the Piece of Wood, and defcended Perpendicularly into the Veffel; to one of 'em we ty'd the Curve Tube CGB, to the other the Streight one DEF, in fuch manner, that the upper Orifice of each, C and D, was a good way below the Rim of the GlafsVeffiel, and the lower Orifices A B, and EF (which as the Tubes themfelves were of about the fame Size) were placed as near as poffible in the fame Horizontal Plane HE.
XX. Now to give a rough Notion of the Eteflure of the Air ; we pour'd fone Pickle into the Veffel up to HI, which running into the Tube B GC, at the Orifice A B, afcended in the oppofite Leg up to the Height $k l$, being Parallel to the external Liquor H I, and there it ftaid.

When we remov'd the Tube, as in the former Cafe, from one part of the Superficies of the Pickle HI, we always found that the Liquor within the Glafs remain'd unchangeably at kl .

From whence it appear'd, in cafe the Air gravitates, which we fuppofe here, that it preffes upon equal Parts, fuch as A B, $a b, \& c$. of the Surface of the Pickle with equal Force : Since otherwife, if the faid Preflure were greater on fome Parts, and lefs on others, the Fluid $k l$ in the Tube, would have rifen or fallen; if otherwife (which follows from what has been fhown already) the Air in the Tube C G incumbent upon $k l$, and higher, does continually prefs upon the faid $k l$ with equal Force. But this by the way.
XXI. Having pour'd in more Pickle, up as high as LM, we found the Liquor in the Tubes to rife to $x y$ and $z 4$; or as in the firf Experiment, to the fame Height as the external Li quor.

But when we pour'd upon the faid Pickle L M, Oil of Turpentine to the Height N O, the Liquor in the Tubes rofe from $x y$ to $n 0$, and from $z_{4}$ to $p q$; but remain'd below O N, or the Superficies of the Oil.

From whence we may infer, that a lighter Fluid, like the faid Oil N OLM, being incumbent upon a heavier, as the Pickle, produces both an upward and downward Preffure: Since A. B mult be preft more downwards to make the Pickle rife from $x y$ to $n o$; and E F with a greater Force upwards, to raife the Pickle from $z_{4}$ to $p q$, and keep it there fufpended.

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XXII. After this we thruft down a Craner or Syphon with a long narrow Tube thro' the Oil N O L M, till it came below L M, or till it reach'd the Pickle; of which as we drew fome part out, we obferv'd, that the Depth of the fame Fiuid in both the Tubes decreas'd proportionably, falling below $n 0$ and $p q$, but rofe again as more Pickle was put in.

The fame Thing happen'd upon taking out, and letting in again any part of the Oil NO.

And fo did the laft, with lifting upwards the Orifices of the Tubes AB, and EF.

From whence it appears, that in feveral Fluids incumbent upon each ether, as well as in one alone, the Preffures which raife and fall the Parts of any Horizontal Plane in each of the Fluids, are likewife adapted to the Depths of the incumbent Fluids.

But they are no ways affected by the Breadth of Fluids, fince it is fufficiently known to all that underftand Hydrofatics, that in cafe the Height of the Fluids over A B and EF continues the fame, the Effect would be the fame ; and the Pickle at $n o$, and $p q$, would continue at the fame Height in Veffels of all kinds of breadths.
XXIII. W elikewife found, that if we carry'd the Orifices of thefe Tubes A Band E F laterally along the Parts of the Horizontal Plane of the Pickle H I (the fame may be faid of the Oil too) the Liquor in the Tubes preferv'd the fame Depth or Height in every new Place upon the fame Horizontal Plane, as was obferv'd in the firt.

From whence it may be concluded, as before, that all equal Parts of a Horizontal Mane, whether the faid Plane runs thro' the uppermof Fluid, or thro' any other which has more Fluids in-
cumbent on it, are preft upwards and downwards with equal Force.

S ect. XXIX. Oil gravitates or preffes on Pickle, in the fame manner as Air does on Water.
XXIV. To reprefent now in a fhort Sketch, how Air operates upon a Fluid below it; we need only pour in Oil till it rifes up to PQ , or above the upper Orifices of the Tubes $C$ and $D$; which by that means running into the faid Tubes, it will caufe the Pickle within them to fubfide from $n_{0}$ and $p q$, to $x y$ and $z 4$, or to an equal Depth with the external Pickle at L M, juft as if the Air preft uponit.

Sect. XXX. The Greatnefs of the Preffure Upwards and Downwards in Several Fhuids incumbent upon one another.
XXV. Laflly, Let us again fuppofe NO to be the upper Superficies of the Oyl. Now to fhow with how much Force every equal Part of a Horizontal Plane H I, fuch as A B, E F, \& © c. are preft upwards and downwards, when there are feveral Fluids incumbent on each other; we pour'd Quickfilver into the Curve Tube A B G C, till it rofe to an equal Height in both Legs, name$l y$, to A B, and $k l$. Then we pour'd into the great Veffel, Pickle as high as LM, and Oyl of Turpentine as high as N O, and fo thruft down the Tube B GC thro' the Oyl into the Pickle, as far as HI ; and when all was quiet and fettled, we found that the Quickfilver had fubfided in one Shank from AB to T U, and rifen in the other from $k l$ to $r$.

This remaining fo, we filled another Curve Tube of equal Legs (Tab. XXV.Fig. 4) 789, firft, paffes as nicely as we could, the Height of the Pickle U W above the Quickfilver T U.
We alfo pour'd Pickle into the other equal Leg'd Tube 78 9, Fig. 4. till it rofe to the fame Height as W U above the Quickfilver that was in it, equal to the Pickle in the Veffel. After which, meafuring in the like manner the Oyl in the Veffel at MO; we alfo pour'd Oyl into the Equicrural Tube to the fame Height W X; fo that the Pickle and the Oyl, as well in the faid Tube, as in the Veffel, were both furpended at an equal Height above the Superficies of the Quickfiliver T U.

I fhould add here, that in order to bring Pickle and Oyi into the Equicrural Tube Fig.4, with thofe in the Veffel, you mult take care you do not pour them in at firft to the Height required; becaufe the Tube not being very large, when that which fticks to the Sides at pouring in comes to fubfide, it will caufe it to rife higher than in the Veffel. This may be obviated perhaps by firft filling the Tube Fig. 4, and then by pouring Pickle and Oyl into the Veffel. They that have a mind may make the Tryal.

Afterwards having meafured with Compaffes the Height $r u$ (which the Superficies of the Quickfilver $r s$ in one Leg, had above the Superficies T U in the other) in both Tubes in and out of the Veffel, we found the fame Height $r$ is to be equal in both.
XXVI. From whence we plainly perceiv'd, that all the Fluids incumbent on each other in the Veffel above $T \mathrm{U}$, and confequently alfo above
above A B, did equally gravitate upon A B in the Veffel; and neither more nor lefs, than if the faid Fluids had been in a narrow afcending Tube, each in its ftreight perpendicular Height.

For fince the Tubes both within and without the Veffel (Tab. XXV.Fig. 3 and 4.) were about the fame Width; if the Side-Fluids in the broad Veffel gravitated more upon A B, than the perpendicular Column A B Y X in the Equicrural Tube upon A B Fig. 4 ; it would follow that the upper Superficies of the Quickfilver $r s$, in the Veffel, would rife higher above the former Superficies $u w$ of the faid Quickfilver than in the Equicrural Tube.
XXVII. The contrary of which being found to be true in all the Parts of a Horizontal Plane, (as H I) where-ever the Orifice of the Tube A B is placed, it fhew'd, That when Fluids are incumbent upon each other in a Veffel, fuppofing in one of 'em a Horizontal Plane, as H I, no Part thereof will fuffer either more or lefs Preffure from all the incumbent Fluids, how broad foever the Veffel is, than of a Column A B X Y; the Bafis of which is A B, and the Top of it reaching up to the upper Superficies of the higheft Fluid N O; and this is what we have call'd the Column of Al titude.
XXVIII. Now as we have defcrib'd above the Column of Altitude in a Fiuid, it may be concluded how the fame is fo plainly defcrib'd in this Cafe; to wit, that in feveral Fluids incumbent upon each other, the Column of Altitude confifts of a Pillar, whofe Bafis or Bottom is A B, or E F, for Inftance, or fome part of a fuppofed Horizontal Plane H I, and whofe Top is the upper Surface of the uppermof of all the Fluids that are incumbent

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upon each other; as for Inftance, B Z compos'd of the feveral Depths of the Pickle B W, of the Oyl W X, and of the Air X Z (imagining that X Z extends itfelf to the upper part of the Air) in fuch manner, that each Height as B W, W X, and X Z preffes downwards with the particular Weight of every Fluid of which it is the Height.
XXIX. It fhould be obferved here, that it is not neceffary that each Part fhould be always preft with fuch a perpendicular Column, fince $a b$ fuffers the fame Preffure, notwithftanding (if we fuppofe K to be a folid Body) that the Column directly incumbing upon $a b$, or $a b m i$, can't extend itfelf in a freight Line higher than to $m i$, provided the Surface of the upper Fluid be at the fame Height as before; but the meaning of all that has been faid is, that both $a b$ and A B are prefs'd with a Weight which is equal to the Column of Altitude, Num. XXVII.
XXX. So that in order to inquire into the Nature of any Water-Works, with refpect to the Preffure of the Water upwards and downwards, you may fingle out a part A B, Fig. 4 . of a Horizontal Plane HI, upon or over which the whole Column of Altitude A B Z may be placed; or otherwife you may lengthen out the Horizontal Plane HI towards N or I, even beyond the Veffel that contains the Part A B, (Tab. XXV. Fig. 3.) upon which we feek for the Preffure, and moreover take an equal Part A B, (Tab. XXV. Fig. 4.) of the faid Plane extended from I to B , on which the Column of Altitude may be fet and reprefented, if we continue the Superficies ML and NO, ©c. of the Fluids incumbent on each other as far as W and X .

So that to know with what Weight $a b$, in the Veffel, is preft ; it may be anfwer'd, with the Co-

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lumn of Altitude A B Z, which is reprefented in Fig. 4. out of the Veffel; of which Column B W is the Pickle, W X the Oyl, and X Z 8 quite to the Top is Air.

We might alfo conceive the Column $a b m i$ incumbent upon $a b$, as paffing thro' a folid Body K, only by afcribing to the Height of each Fluid Matter in it, its particular Part and Weight.

Sect. XXXI. Of the Prefure upon equal Parts of Higher or Lower Horizontal Planes.
XXXI. $I_{T}$ is unneceffary to add farther, that (Tab. XXVI. Fig. 2.) the Part $d$ lying in the Horizontal Plane G T, is preft with fo much more Force upwards and downwards, than the Part $c$ in a higher Plane E F, as the Column of Altitude $f m$ upon G T, is heavier than the Column $f b$ incumbent on the other Plane E F. This every one may apply to a Parte in a lower Plane NH , as alfo to feveral Fluids lying upon each other.

Sect. XXXII. Hydrofatical Laws of Several Fivids incumbent on one another.
XXXII. $\mathrm{F}_{\mathrm{r}}$ ом all which then, there follows this great Hydroftatical Propofition (which does likewife very much contribute to difcover the Powers and Motions in Hydraulicks, or WaterWorks) after a fhort and plain Manner.

It is thus :
If feveral Fluids be incumbent upon each other, and we fuppofe one Horizontal Plane, as HI (Tab. XXV.Fig. 3.) paffing thro' one of 'em :

Two or more equal Parts thereof (as AB, $a b$, E F, $\uplus_{c}$ ) will each of 'em be prefs'd upwards and downwards, with the Weight of their Columns of Altitude, and confequently with equal Force.

From whence it follows,
That

That one of thefe Parts, fuch as A B, is prefs'd downwards with the fame Force as another $a b$, or E F, upwards.

And on the contrary :
That the firf A.B is prefs'd with as great Force upwards, as another $a b$, or EF downwards; which we fhall therefore, for Brevity fake, call here the Law of Altitude or Depth, becaufe it adapts itfelf only to the Height (or Depti) of Fluids, but by no Means to their Breadth or Surface.
XXXIII. $I_{T}$ muft be here obferv'd, that in the upward and downward Preffure on equal Parts of the fame Horizontal Plane (we do not now fpeak of higher or lower Planes) it is meant of fuch Parts A B, $a b, E F$, ofc. which have a Communication with each other in the fame Fluid ; that is, fuch as from one of which there may be fuppofed a Thread or Line drawn to the other, without being obliged to pafs thro' another Fluid, or Solid Body.

It is neceflary to lay down this Caution here, becaufe this fo general Propofition may otherwife not fucceed in fome Clafes.

Sect. XXXIII. The Prefure upwards proceeds only from Lateral Fluids.

We have no occafion to prove exprefly, that all Parts, as rt, (Tab. XXV. Fig. 2.) of a Horizontal Plane L M, are prefs'd downwards by their own Weight, and that of other incumbent Fluids ; but that they are never prefs'd upwards, but by Fluids that are not only higher bat alfo lateral ; and other parts of the fame Horizontal Plane L M prefs downwards: So that all upward

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ward Preffure proceeds from thefe Lateral Fluids, as from their nearelt Caufes.

For take away the Lateral Fluids that are in the Veffel $a \mathrm{LM} b$, on the Outfide of the Tube $r t \mathrm{TV}$, the Liquor in the faid Tube, lofing its preffure upwards, will immediately fubfide.

> Sect. XXXIV. Oblique Prefures do likewife adapt themfelves to the Height of Fluids.
XXXV. Now to fay fomething concerning the Oblique Preffures of Fluids.

That Fluids may be prefs'd and protruded in various Obliquities, is fo plainly proved by the Cocks and Ajutages of many Fountains, as not to require any farther Demonftration here.

But that thefe Oblique-preffing Fluids do alfo adapt themfelves to the direct perpendicular Height of the faid Fluids over the prefs'd Part, as the foregoing, and by no Means according to their Quancity or Obliquity, fhall be likewife briefly fhown.

Take a Recurve Tube (Tab. XXVI. Fig. 3. and 4.) A BCD, which being continued from CD, affumes the Form of CEF ND; pour Water into it up to A, whereupon you will find that the Water will fpread itfelf till it attains to an equal Height in the other Leg EF, of whatfoever Oblique Shape the faid Leg C DE.F be, with refpect to the prefs'd Part C D.

Now we know, that if the Tube were extended from CD, ftreight up to CGHD, and and were full of Water as high as GH, or at a Height equal to A L and E F , the perpendicular Column C G H D, would keep the Water in the Tube A. B, to the fame Height A B, juft after the fame Manner as here in the Oblique Prefure EF N D.

Confequently the Horizontal prefs'd Part C D, undergoes an equal Preffure from the freight Co lum CGDH, as from the Curve or oblique one C D F ND.

And this would be juft the fame, and remain fo, though the Curve Tube (Tab. XXVI. Fig. 4.) were widen'd as at CEFK D, or even narrow'd in any other manner, fo as to contain a greater or leffer quantity of Liquor; as likewife in which Obliquity, one of the faid Tubes ftood upon the Plane B CD, and prefs'd the Part CD; if only the prefs'd Horizontal Part C D preferv'd the fame Magnitude, and the Perpendicular Height G C, HD, or F M of the Fluids upon the Plane $C D$ continued the fame.

Sect. XXXV. The Hydroftatical Laws of Oblique Prefures
XXXVI. So that the foremention'd Law of Altitude, is here alfo of full Force in the Cafe of Oblique Preffures; and the following Propofition is true :

If a Part CD of a Horizontal Plane B C D, is prefs'd by a Curve or Oblique Column of Water CEFND; the Preffure it undergoes is neither greater nor leffer, than that of the Column of Altitude; that is, of the Perpendicular Column C G H D, which has for its Bafis the prefs'd part C D, and for its Height the ftreight Perpendicular Lines F M, or G C, which are extended from the prefs'd Part C D, to the uppermof Superficies A F of the higheft Fluid, fuppofing there to be more than one.

Sect.

Sect. XXXVI. Lateral Preffures do likewife adapt themfelves to the Heights or Depths of Fluids.
XXXVII. It now remains to inquire into the Force of the Lateral Preflure of Fluids, whereby they are thruft or prefs'd along the Horizontal Line.

That this kind of Preffure does alfo obtain in Fluids, appears from the fitting or placing Cocks in the Sides of Barrels, \& $c$.

Or otherwife, fix a Tube EF (Tab. XXVI. Fig. 5.) horizontally, or into the Side of a Veffel ABCD, fill'd with Water to the height MN, and you will fee the Water gufhing out in aStream FGH; fo that at EF it runs horizontally, and at F GH inclines or bends itfelf to the Earth.

And in order to know that this Lateral Preffure does alfo adapt itfelf to the Height, you need only fill the Veffel up to A B, fo that there will then be a greater Depth of Water E B above the Tube E F; and you will find that the Stream FIK gufhes out fo much farther, and horizontally to K ; but that in Proportion to the De creafe of the aforefaid Height, by letting out the Water, the horizontal Force does allo decreafe, and continually incline nearer to the Veffel, as firft at H and then at P .

Now that this Lateral Preffure does by no means adapt itfelf to the Breadth or Quantity of the Water, may be feen, if by continually pouring Water into the narrower and wider Veffel, fuch as ABCD (provided it be not too narrow) the Water be kept at the fame height AB; for then in both Cafes the Stream FIK will preferve the fame Horizontal Line.

$$
\text { Vox. IIL. } \quad \text { Mmm } \quad \text { SEGT. }
$$

Sect. XXXVII. The Metbod of difcovering the Greatnefs of the aforefaid Preflure.
XXXVIII. Bu t now in order to compare the true Force of the Lateral Preflures, with that of the Heighth or Depth of Fluids upon equal Horizontal Planes, as we have done in other Preffures, we mult beftow fomewhat more Pains.

For if we take a quadrangular Veffel (Tab. XXVI. Fig. 6.) A QP K with plane perpendicalar Sides AQ, and PK; and in it conceive the part AE of the Side A Q, againft which the Water, wherewith it is fill'd up to A K, preffes laterally, and if you moreover conceive another part $E$ I in the Horizontal Plane O E, and equai to AE; it is clear that upon each Point F, G, H, I, there is an equal Depth of Water a F, c G , e H, gI, and confequently that each of the faid Points is prefs'd downwards with an equal Force; but neverthelefs, that each of thofe Points B, C, D, E, in the perpendicular Part A E, fuffers an unequal lateral Preffure; becaufe, as we have fhown before, the lateral Preffure accommodates itfelf to the perpendicular Height of the Water, and fo is greater or lefs accordingly; and each Point, as A, B, C, D, E, has a different Height of Water above it, or rather above the Horizontal Plane in which each Point lies.

Accordingly the Point A, or the Horizontal Plane A K, has no Height of Water above it.

The Point B, or the Plane B L, has the Height A B or $a l$ over it.

The Point C, or the Plane C M, the Height AC , or $c d$.

The Point D, or the Plane D N, the Height $A D$, or $e f$.

The Point E, or the Plane E O, the Height A E, or $g i$.

So that from hence it is manifeft, that in order to know how much greater or fmaller Preflure the Horizontal Plane EI undergoes from the Water that lies in equal Height uponail its Points, than the Perpendicular A E, which has different Herghts of Water over all its Points ; that by reafon of the great Difference of the Height of Water lying over the higheft and loweft Points of the perpendicularly prefs'd Part A E; to avoid Mittakes, we mult Firft inquire how much greater or fmaller the lateral Preffure (for Inftance) upon one of the Points B or C, $\mathscr{\sigma c}$. is, than the Preffure downwards on one of the Points $b$ or $d, \delta c$. which have the fame Height of Water over them.

And, Secondly, when this is known in each Height $a, b, c, d, e f, g, i$, that we compare the Sum of all thefe different lateral Preflures upon all the Points or little Planes that make up E A, with the Preffure downwards, which all the Points or equal Breadths compriz'd in EI, do bear together.

Thirdly, It is plain, that the fmaller the Parts or Points are into which $\mathrm{A} E$ and EI are divided, the leffer is the difference of the Heights or Depths of Water over the uppermoft and undermoft Points of the Part of A E, and confequently thefe Diverfities of the Heights will produce the fmaller Change in the Calculations, which, if thefe Parts were taken very large, might occafion great Difference; whereas they may be now fafely enough taken, if we confidet the Parts of A E, fuch as A, B, C, © Cc. as very fmall, and mere Points.

Sect. XXXVIII. The Comparifon of the Lateral and Perpendicular Preffure of the Air upon an equal Part Jbown by an Experiment.
XXXIX. To fhew the Firfe experimentally, to wit, that the lateral Preffure which fuch a little Part as B, having a Height of Water, as A B, above it, undergoes in the Perpendicular A E, is equal, or at leaft does not fenfibly differ from the Preflure downward, which a Horizontal equal Part $b$ that has an equal Height of Water $a b$ over it, fuffers from the incumbent Fluid, may appear from what follows, propos'd, if I miftake not, firf by Mr. Mariotte, but with another View.

Having try'd the fame in the Year 1696, and feveral times fince, I find among others, the following Remarks, which every Body elfe may alfo make by the help of the little Glafs Inftrument invented by Dr. Mufchenbroek for the fame Purpofe, with little Charge and Trouble.

We caus'd a little Hole $a b$ to be drill'd orbored in the Plane Side V Q of a Bottle A B PQ (Tab. XXVII. Fig. r.) and another fomewhat bigger at the Bottom of the faid Bottle at P , which laft might be ftopt by putting fomething into the Hole, and the Mouth A B was ftopt with a Cork C D F G, thro' which the Glars Tube E W was thruft, and the Joints were fo well fodder'd with Emplaftrum de Minio, that no Air could pals neither between the Tube and Cork, nor the Cork and the Mouth or Hole.

Then ftopping the little Hole $a b$, and the Glafs Tube E with the Finger, we pour'd Water into the Veffel thro' the biggeft Hole P with a Funnel that had a very flender Nofe, till it afcended

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ded to the Height R T, or higher than the little Hole $a b$, which otherwife requires no Bounds.

Moreover having clos'd the Hole P with a Cork or a Plug, we thruft a little Tube $a b$ $g b$ a-crofs in the Orifice $a b$, which Tube being fhut, or hermetically feal'd at $g h$, had a Horizontal Orifice at $f g$, as that at $a b$.

Then fetting the Veffel up an end again, and ftopping the Orifice $f g$ with the Finger, we fill'd the Tube EW almoft to the Top with Water. After which I removed my Finger from $f g$, whereupon the Water fpouted out of the faid Orifice $f g$, and fubfided in the Tube E W; but without producing any other Alteration or vifible Diminution in the Height of the Water R T in the Veffel, than what might be juftly afcribed to the Contraction or Expanfion of the Air incumbent on the faid Water R T.

Finally, All being at Reft, it appear'd, that as the Water in the Veffel continued at R T, that in the Tube E W ftopt at $d u$, at the fame Height with $f g$, or with the Horizontal Plane $d g$, which paffes thro' $d u$ and $f g$.

Whereby we perceiv'd that the Column of Air $f g \mathrm{~K}$, by its perpendicular Preffure upon the Water at $f g$, could keep the fame fufpended at the Height of $d u$ in the Tube E W, and ballance an equal Column of Air $d u \mathrm{H}$, which incumbed upon $d u$, according to Sect. XLI, ©̛c.

Now to compare the lateral Preffure upon $a b$, with the perpendicular Preffure $f g$, we took the little Tube $a b b g$ out of the Hole $a b$, and found that every Thing continued in the fame State, and that hardly any Water flow'd out of the faid Hole $a b$; the Water alfo in the Tube E W remaining at the fame Height $d u$.

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For if it had fallen in the faid Tube, but a Hairs Breath, down to e $w$, by reafon of the Difference of the Air's Height at $a$ and $b$ (which however was not obfervable) the fame by making the Hole $a b$ fmaller, would have dwindled to nothing.
XL. Suppofing then that the Water in the Tube E W did continue at the fame Height, whether the Air prefs'd downwards upon $f g$, or a-crofs and fidewife, upon $a b$, without the little Tube $a b$ $g b$, it was plain, that the Air prefs'd with much the fame Force by its Weight directly downwards and laterally or fidewife, when thefe prefs'd Parts $f g$ and $a b$ were takén fo fmall, that the Heights $\mathrm{I} a$ and $\mathrm{I} b$ differ fo little.

Sect. XXXIX. An Experimental Comparifon of of the aforefaid Preffures in Water upon an equal Part.
XLI. But fince the abovemention'd Experiment does only fhew the Equality of thefe Preffures in Air, to the end, that the fame may be reprefented in fome other Fluid, as Water for $\ln -$ ftance, we placed the aforefaid Bottle ABPQ, with and without the Tube $a b g h$, in a Veffel of Water LM N O: So that the Water in the Veffel was as high as L O above that in the Bottle, and we obferv'd in both Cafes that the Water in the Tube E W, rofe and continued at $r z$ an equal Height with that in the Veffel L M, and confequently higher than that in the Bottle RT. So that the Water in the Veffel L M IV O, whether preffing perpendicularly upon $f g$, or laterally againft $a b$, exerted an equal Force and Preffure upon equal Parts, as $f g$ and $a b$, when taken fmall enough.

Sect. XL. The Greatnefs of a Lateral Prefure upon a Plane.
XLII. From whence it foliows, that we may return again to our former Thread, and to Tab. XXVI. Fig. 6. and compute what a Force of Preffure a perpendicular Part A E fuffers laterally from the Water as high as $\dot{A} \mathrm{~K}$ in the Veffel $\mathrm{A} Q$ PK, in comparifon of the Force which an equal Part EI, lying horizontally, undergoes from the incumbent Water A Eig; we muft firft fuppofe the prefs'd Parts or Planes A E and EI to confift of other fmaller Parts, or of very fmall Points, $A, B, C, D, E, F, G, H$ and $I$.

Secondly, That each of thefe Points or little Particles B, C, \& c. does fuftain juft as ftrong an Action from the lateral Preffure, as $b$ and $d$ from the Preffure downwards of the vifible Heights $a b_{3}$ $c d$, \&c. of their incumbent Water.
XLIII. Let us then for Conveniency fuppofe that A E alone does confift of five equal Parts, A, B, C, D, E, and E I of five Parts alfo, E, F, G, H, I: Tho we hhould proceed more furely, if we fuppofed thefe Parts to be much fmaller, and that AE as well as EI, did confift of fome Thoufands or Millions of the faid Parts; forafmuch as then the Heights $a b, c d, \& c$. of the higheft and loweft Ends of thefe Parts would hardly be different, as has been already mention'd above.

We have however taken fuch a fmall Number as 5 here, it being fo reprefented in the Figure, and becaufe, whether the Number of the Parts be great or little, the Iffue of the Calculation will be the fame.

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To come to it therefore; If it be fuppofed that the Height $a b$ contains I Pound, that $c d 2$ Pounds ef 3 Pound, $g$ I 4 Pounds, and fo on, if more Parts be taken, it has been proved before, that there is an equal Lateral Preffure upon the Point $A$, as downwards on $a$, and becaufe there) 16 . is no Height or Column of Water in- 0 cumbing on $a$, it bears
On B as on $b$, and by reafon of the? Height $a b$,the faid $b$ bears
OnC as on $d$, and becaufe of the Height $c$, it bears
On D as on $f$, and becaure of the Height $\}$ $d f$, it bears
On E as on I, and becaure of the Height \} $g \mathrm{I}$, it bears

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4
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So that the Weight which all the Points $\}$ noft. together bear, is
Furthermore: Each of the Points E, F, G, H, I have incumbing on them a Height or Column of Water equal to 8 I , and confequently each bears 4 l . 20 ft . which being multiply'd by 5 , there being fo many Parts fuppos'd in AE, and EI, the whole EI bears

## Sect. XLI. The Hydrofatical Law of Lateral Preflures.

XLIV. From whence therefore refults this Principle concerning the lateral Preffure of Fluids, namely, that the latezal Preffure upon A E being, in this Cafe, to tb . is the half of 20 tb . or of the Preflure downwards, which the faid AE if it lay horizontally at E I, level with the loweft Point E , wou'd fuffer from its incumbent Water AE I $g_{g}$ fo that in order to know, the Water being at the Height A K , how great is the Prefure which AE bears, we muft fet off A.E horizontally on E I, which bears the Preflure downwards of its incumbing Water A EI $g$; and draw EI, which will take in the preffing Fluid A E I A, or the half of A E I $g$.
XLV. It mult not be thought that if the Number of Parts, of which A E or EI are compos'd, were much greater than 5, it would alter the Proportions; fince, let the Number be never fo great, all the Numbers from of forwards, being continually multiply'd with the Unir, do always make up the half of their greatef Number fo often taken, as (the o or Cypher being reckon'd among them) their Quantity amounts to.

This is plain to Mathematicians, and any body elfe may, for his Satisfaction, compute it with a greater Quantity.

Sect. XLII, and XLIII. Two Experiments about Lateral Preffures.
XLVI. You may find what we have faid Num. XLIV, and XLV. demonftrated after another manner by Monfieur Stevin, in his Hydroftatics; but fince we, in order to render our Conclufions more certain, are wont to deduce our Proofs from Experiments, we will here add the following Experiment, as we find it ftanding upon our Notes fome Years ago, omitting the whole Calculation for Brevity fake.

We caus'd to be made a Quadrilateral Veffel (Tab. XXVII. Fig. 2.) the Height of which M K was about 26 Inches, with a fquare Hole that could be ftopp'd with a Piece of Wood HDR S of the like Dimenfions, being of the Breadth of a Foot at R D, and of the fame Length at H D, which Piece of Wood was adapted to the Hole after fuch a manner with a Leather fix'd to its

Edges, as to prevent the Water from oozing out at the Joints.

This Veffel being fill'd with Water up to B D, we knew that there was the Weight of a Foot of Water preffing laterally upon the Piece of Wood H D R S, becaufe the Height of the Water was equal to D R, or to the Height of the uppermoft Part of the faid Piece of Wood.

Having then examin'd into the Force of this lateral Preffure of the Water by Means of a Ballance A EF, the Arms of which A E and EF were Rectangular at E , to which the Weight Y was fufpended, we found that this Wood being prefs'd inwards at E A by Y, could refift a Weight of between 31 and 32 Pounds; but upon adding more it immediately burft inwards.

So that the Rule mention'd in Sect. LII. was fufficiently verified hereby, fince a Rynland Foot of that Water was about twice as heavy.

It is to be obferv'd, that the preffing Part A of the Ballance AEF, muft be placed exactly upon the Point of the Wood A, where the Centre is, or where the lateral Preffure is ftrongeft.

In order to do fo, Care was taken that by the Means of the crofs Piece of Wood VW, the Axis E of the Ballance might be thruft up or down; and we found that when the Ballance prefs'd higher or lower than A, the flat Piece of Wood (the Water being at higheft) yielded to a much fmaller Weight or Preffure; which fhew'd that the true Point was at A.
XLVII. We then fill'd the Veffel quite full of Water up to GK, fo that the upper Part DR of the wooden Plane DR S H, which bears the leteral Preflure, was not equal to the upper Superficies of the Water, but was below it the Length of $K$ D or of ; of a Foet, that is, 8 Inches. Where-

Wherefore if what is faid before be true, and that HK were $\mathrm{I}_{3}^{2}$ of a Foot, or 20 Inches, we fhould have feen the lateral Preflure on H D R S refift a greater Weight.

Having therefore rais'd the Axis a little higher, fo that A, the End of the Ballance, being hereby apply'd to the Center of the Preflure, was alfo higher, we found that by putting on the Weight Y of 77 Pounds, the wooden Plane immediately gave way, but that the lateral Preflure held good againft 73 or 74 Pounds.

This agreed pretty near with the foregoing Rule, as we found by computing after the following Manner:

Let Tab. XXVII. Fig. 2. be transferr'd to Fig.3. and that the Water is from H S to K Z. Then HK equal to $\mathrm{r}^{\frac{2}{3}}$, or $\frac{\frac{\pi}{3}}{}$ of a Foot is equal to $\mathrm{P} \mathbf{H}$ (if we fuppofe this fame H K to belying horizontally) and HS is a Foot: So that the whole Body of Water of this Breadth, Length and Depth $\frac{25}{9}$ of a Cubical Foot; and the half of it, which preffes laterally upon $\mathrm{K} \mathrm{H} \mathrm{Z} \mathrm{S} \mathrm{will} ,\mathrm{be} \frac{25}{18}$ of a Foot. If now we fubftract from thence the Water's lateral Preffure upon K D R Z, to wit, $\frac{4}{88}$ of a Cubical Foot, it being the Half of $\frac{4}{8}$ a Foot of Water (which laft expreffes the Magnitude of a Body, the Length whereof R D is r Foot, the Breadth $m \mathbf{D}^{\frac{2}{3}}$, and the Height K D likewife $\frac{2}{3}$ of a Foot) there will remain the lateral Preffure of $\frac{2}{\frac{2}{8}} \frac{7}{8}$ or $\frac{3}{6}$ of a Foot, or otherwife $1^{\frac{5}{6}}$ of a Cubical Foot of Water, that is (fuppofing fuch a Foot of Water to be 63 Pounds, or fomewhat more) of $73^{\frac{\pi}{2}}$ Pounds againft HDR S; which fufficiently agrees with the Rule mention'd Sect. LII.

Sect. XLIV. The Lateral Preffure adapts itfelf to the Height, and not to the Breadth of Water.
XLVIII. We likewife obferv'd, upon placing a flat Board or Partition (Tab. XXVII. Fig. 2.) T $a b$, after fuch a manner, that the Water, which before prefs'd upon DHRS, became divided, or had not above the half $a \mathrm{~K}$ of its former Breadth K G, that the lateral Preffure was not leffen'd, whilft the Water continued at its firft Height K G.

So that from hence alfo it appear'd, that the Powers of the lateral Preffure remain the fame, whether the Breadth of the Water be increas'd or diminih'd ; but that upon augmenting or leflening the Height of Water, thofe Powers are accordingly augmented or leffen'd.

> Sect. XLV. The Lateral Preffure of Water, with Air preffing upon the fame.
XLIX. But forafmuch as in thefe Experiments of Lateral Preffirres we have fuppofed Water to be the uppermoft Fluid, fo that, for initance, in the Veffel A B CD (Tab. XXVII. Fig. 4.) we are to fuppofe there is no other Fluid Matter above the Superficies of the Water A C, the following Difficuity feem'd to arife, namely, that the lateral Preffure of the faid Water A C upon A B would be much greater than it is found to be by thefe Experiments ; becaufe the Air between AC and and 000 , ofc. actually preffing upon A B with the Weight of 30 Foot of Water (according to the Parometer) the lateral Preffure againft A B would appear to be confiderably encreas'd.

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But upon the whole Matter, we fhall fhow by the following Calculation, that the lateral Preflure of Water in the Veffel A BDC upon A B, is not fo much increas'd by the Weight of the Air above A C, as that the Force which A B withftands, or which fhould prefs inwardly againft C D (like the Weight in the foregoing Ballance, Fig. II.) could be fenfibly augmented thereby.

Let the Veffel A B D C (Țab. XXVII. Fig. 4.) be fill'd with Water up to A C ; above which let us fuppofe a Column of incumbing Air as high as 000 R 000 ; we know that the faid Air being alfo on the other Side of $A B$, at $A, B, i, n$, will prefs likewife againft A B laterally from the Side of $n i$.

Now to find what Preffure AB undergoes by the Water on the Side D C, and by the Air on the Side $n i$, and how much the firft Preffure exceeds the laft :

Let us call the Weight of the Air gravitating upon each Point in the Plane $n \mathrm{~N}$, to wit, $n \mathbf{O}$, $m \mathrm{O}, \mathrm{E} \mathbf{O}, \dot{\sigma} c$. by the Name of $a$.

Let the Gravitation of the Water K F on the Point F be $b$, then L G is $2 b$, and $\mathrm{MH}_{3} b, \dot{\sigma} c$.

Let the Air-Weight of $k f$ on the Point $f$ be $c$; then is $\mathrm{L} g, 2 c ; m b, 3 c$, \&cc.

Whereupon (according to the Calculation in Sect. LI. if we do here alfo fuppofe five Points of Preflure) the Force of the fuperior Air, and of the Water in A B C D, which prefs A B laterally towards $n i$, will be $5 a$ with rob. And on the contrary, the Force of the upper Air, and of that Air which is at $n i$ B A, which prefs'd A B laterally back towards D C, will be $5 a$ with io $c$. So that thefe two Powers preffing laterally againft each other, being drawn by each other, the Force wherewith A.B is prefs'd laterally towards $n \quad i_{2}$ will be io 6 lefs io 6 .

Now without the fuperior Air, the lateral Preffure of the Water (according to Sect. LI and LII.) would be equal to $10 b$; and $c$ is equal to about $\frac{x}{2000}$ part of $b$, if we fuppofe Water to be 1000 times heavier than Air. So that the furrounding Air does only leffen the lateral Preffure of the Water $\frac{3}{5000}$ part ; which in the foregoing Experiment can make no fenfible Alteration, and confequently the abovefaid Difficulty is obviated.

Sect. XLVI. The Augmentation and Diminution of the refffing Force of Fluids produces Motion, and the Force thereof.
L. Hitherto we have confidered the upward and downward Preffures of Fluids which are quiefcent or ftagnant, either by reafon of Powers really acting upon and againft each other, or elfe by the Refiftance and Obitructions of Motion; we fhould now naturally proceed to inquire into the Powers of thofe Fluids that are in actual Motion; but forafmuch as this would require a whole Book to account for it, and fince what we propos'd to fhew here concerning the Law of Altitude or Depth, may likewife be conceiv'd by the Preflure of fagnating Fluids; we will not inlarge this Digreffion, which to thofe who underftand Hydroftatics, may feem already much too long.

We fhall only obferve further concerning the Powers preffing upon each other, that if in Tab. XXVII. Fig. 5. the Tube $b \mathrm{~kg}$ is equally fill'd with Water up to $a$ and $f$, fince $d$ is prefs'd upwards by $a b$, and downwards by $f d$, the Part $d$ will quiefce or ftand ftill, if the Powers $a b$ and $d f$ are equal; but if one of 'em be leffen'd to $e d$, or the other increas'd to $b b, d$ will be removed towards that Side where the Force is fmalleft, or in this cafe tog; and even with as much Force, as the Difference of both Powers is, that act on each Side upon $d$. This may be eafily try'd, and wants no further Proof.

Sect. XLVII. Fluids are moved by, or rather after taking away a Refiftance, and the Force thereof.
LI. Motion may likewife be produced, by removing a Refiftance which obftructed Motion. For Inftance, blow into a Tube at $g$, which is fill'd in both its Legs with Water up to a and $f$, till the Water fubfides from $f$ to $e$, and rifes from $a$ to $b$ on the other Side; then prefently ftop the Orifice $g$ with your Finger, whereupon all will ftand Itill, and your Finger will become the Impediment or Refiftance of Motion. This appears by removing your Finger, upon which the Motion will enfue.

Now by what has been faid it is obvious, that whilft the Finger continues upon $g$, and the Fluid is ftagnant, the Part $d$ is prefs'd upwards by $b b$, and downwards by $d g$; and that the refifting Power or Finger is prefs'd upwards by the difference of the Powers $b b$ and $d g$. So that this Refiftance or Finger being taken away, a Motion will be made towards the Side of the Refiftance; and even with that Force with which the Refiftance was prefs'd when the Fluids were quiefcent, unlefs upon removing the Refiftance, no other actual Force begins to operate.

Sect. XLVIII. Tranfition to Hydraulics, or fome few Hydroftatical Examples.

Now that Fluids do fo exactly obferve thefe Laws; that Firft, every thing which is deduced from thence by good and juft Confequences (all Circumftances being rightly obferv'd) is likewife Expe. duce Effects which, to fuch as are unexperienced in Hydroftatics, appear to be fo many Wonders, and of whofe manner of Operating, even the greateft Mathematicians acknowledge themfelves ignorant, or at leaft uncertain, we will prove by fome few Inftances.

## $\mathrm{S}_{\mathrm{E}} \mathrm{CT}$. XLIX. Calculation of the Force of a Syphon.

LII. The Firft Inftance, that we may begin with one that is fimple, fhall be the Operation of a Sypbon.

ABCD is a Veffel fill'd to the Brim with Water (Tab. XXVIII. Fig. I.) in it there is placed a Curve Tube or Syphon E G H K, likewife full of Water, the Orifice whereof 1 K is for that purpofe flopt with the Finger or otherwife.
If now you remove your Finger from $\mathbf{I K}$, every Body knows experimentally, that the Water will run out from I K to Z, rifing up in the mean while in that Part of the Syphon E G which is fhorteft, and coming down in the longeft HK, as long as the Water in the Veffel continues higher than the Mouth of the fhorteft Leg EF.

Now to know from the foregoing Principles, the Force and Manner whereby, and whereon this Operation of the Syphon is brought about :

Stop the Syphon again with your Finger at 1 K , by which means the Water in that, and in the Veffel will fagnate.

Suppofe then W X to be the upper Place of the Air which preffes here upon the Water, and pro-
duce the Horizontal Plane of the Water A D, thro' P Q to R S, where of L M, NO, P Q and R S are equal Parts; thereupon according to the preceding Rules, the Part LM will be prefs'd with the Weight of the Column of Air incumbing on it.

Let us for brevity fake call the Preffure of Weight thereof upon L M, $a$, or if you pleafe 100 Pounds more or lefs; efpecially if People be not ufed to this way of Letters.

Accordingly we will exprefs the Weight of the Water-Column P QI K by $b$ or ro Pounds, and that of the Air RSTV, being of the fame Height, by $c$ or I Pound.

Now fince L M, N O, P Q, which are all equal Parts of the fame Horizontal Plane A Q, and all Water, and to all which we may fuppofe, that a Line or Thread may be drawn, without paffing thro' a folid Body, or any other Fluid befides Water.

And fince by the Action of the Syphon the Plane L M moves, or is prefs'd downwards, that of NO upwards, and that of P Q again downwards, if every Thing be reduced to Reft by ftopping the Orifice I K, the Powers whereby the faid Planes were prefs'd up and downwards will be equal, according the SeCZ. XLI, ©c. and LM being prefs'd downwards by the Weight of the Air-Column L W M, that is, by $a$, or by 100 Pounds, N O will be prefs'd upwards, and P Q downwards by the fame.

If now we joyn to the Weight of this Air-Column of $a$ or 100 Pounds which preffes .P Q downwards, the Water-Column PQIK of $b$ or 10 Pounds, by which I K is likewife prefs'd downwards ; the Force or Weight that preffes I K will confift of a joyn'd to $b$, or of 100 and so Pounds, to wit, of the Air and Water-Co-

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If now the Horizontal Plane paffing thro' I K be extended to $V$, and $T V$ fuppos'd equal to I K , then will $\mathrm{T} \cdot \mathrm{V}$ be prefs'd downwards by the whole Air-Column TV X, that is by R S X of a or soo Pounds (the fame being equal to L M W) and by R S T V of $c$ or I Poind, that is, of $a$ and $c$ or roo and I Pounds together.
Now with jut fo much Force (according to Sect. XLIII.) is the Part I K, or rather the Air preffing againft $I K$, or the Finger (if we do not confider the thicknefs thereof) prefs'd upwards.

So that we fee here two Powers preffing againft each other on IK, or the Separation of the Water and Air, operating and acting againft one another.
Of which, that that preffes $I \mathrm{~K}$ downwards, has been found already to confift of $a$ added to $b$,or 100 and 10 Pounds. And that which preffes IK upwards, to be no more than of $a$ and $c$, or 100 and $\mp$ Pounds; fo that this laft, $a$ and $c$, or 101 Pounds, (i. e. the fmallef Sum) being Subtracted from $a$ and $b$, or rio Pounds, the Remainder is $b$ lefs $c$, or ro lefs I , that is 9 Pounds.

And this fnows the Force wherewith $I \mathrm{~K}$ is prefs'd downwards more than upwards, and it is equal to the Weight by which the Water-Column RQKI, $b$ or ro, exceeds the Air-Column PSTV, $c$ or x .
So that if you remove your Finger from I K, and fuffer thefe two reciprocally graviating Powers to act againft each other, it is plain, that the Water at the Orifice of the Tube 1 K , is by the lately mention'd difference of Weight between the two Columns P Q K I and R S TV, that is 6 lefs $c$, or 9 pound Weight (fuppofing all the Num-

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bers to be as above) prefs'd or protruded downwards to Z .

Thus we fee the Force wherewith a Syphon flows, deduced from the aforefaid Principles, and the Fact is obvious to every one.

But we mult beg our Readers to take notice here, as well as to remember hereafter, that we do by no means pretend that thefe Numbers of 100, $1,10, \mathrm{o}^{2} \mathrm{c}$. are the juft Proportions of the Weight of Water and Air ; but that we only mean thereby, to fhow that a Column of Water is much heavier than a like Column of Air, and to confult the eafe of thofe who are not accuftom'd to Lettersin Calculations.

> Sect. LI. Of a Fountain that Spouts or Springs bigher than the Water that fupplies it.
LIII. Let us now propofe an Inftance that is a little more compounded than the former.

How to make a Fountain whofe Stream rifes much bigher than the Water above in the Ciftern, which caufes it to fpring out without the Application of any Force Pumps, Beliows, or other Inftruments, and without any otber Means whatever, faving the Gravity or Weight of the Water itfelf:

This may be done after the following manner.
A B CD (Tab. XXVIII. Fig. 2.) is an open Ciftern, from which an open Tube NR is carried downwards thro' the Covering EH of another Ciftern EFGH, thut fo clofe that no Air can get in, paffes down to $R$, almof to the Bottom of the Cittern F G.

From the upper Part of this loweft Cittern E H, there rifes a fecond Tube $S T$, paffing on almoft as high as T D, or the Lid of a fecond Ciftern DCKI, which is likewife clofed; and from thence there is again derived a third Tube to $\mathrm{Nnn}_{2}$ L M Q

L M Q , which is ftopt with a Cock that has a large Orifice at M O.

Moreover in the Ciftern DCKI, there is a Hole at P , which can be open'd and fhut by another Cock or Stopper.

To fet this Machine to Work :
Pour in Water at the Orifice $P$ into the Ciftern D C K I, till the Tube L Z QO be full, fhut the Cock $M O$, continuing to pour in Water at $P$, till the Water rifes in the faid Ciftern to the Height T Y, or level with the Mouth of the Tube T .

Then flut the Cock P, and pour Water into the Ciftern A B CD till it rifes to the Height 2 T. This is not indeed abfolutely neceffiary here, but is prefcrib'd to the End, that by taking the fame Height of Water in both the upper Cifterns, the Calculation may be the more Simple, and confequently more Intelligible to unexperienced Perfons.

This being done, and every Thing at Reft, upon opening the Cock MO, you will fee the Stream of Water rifing up to $V$ thro' the middle Orifice of the flat Plate 56 , or at leaft to a very confiderable Height above the uppermoft Superficies 2 T of the Water which is in the Cifterns A BCD, and DCKI, and which preffes up the Stream 6 V .

It muft be here obferv'd, that forafmuch as the Water of the upper Ciftern A B C D defcends into the lower EF GH during the Play of the Fountain, there mult be a Hole in the latter from whence the Water may be difcharged, which being done, it muft be ftopt again, if you would play the Fountain again.

Or otherwife (which I find moft convenient in mine) you may place a little Pump at 2 thro' the Tube NR, down to the Bottom F G, and then

Pump the Water out of the lower Ciftern E F G H thro' N , the Cock being open'd in the Ciftern D CKI.

To know then with what Force the Stream rifes from the Cock N O, or the Orifice 56 :

Let the faid Cock be turn'd or fhut again, whereupon the upper Cifterns and Tubes being fill'd with Water, all will be fill; and let it be fuppos'd (that we may not repeat the fame) that all the Tubes as well the real ones N R, T S, L Z, as the imaginary ones $W_{2}, \mathrm{X}_{4}$, and 45 , are of the fame Width. Tho' this likewife is only requir'd for Calculation fake, fince we may otherwife ufe for this Purpofe, fuch a Part only of a larger Tube as is equal to the Width of a fmaller.

Let then iW X be the uppermoft Plane of the external Air; and let that of the Water T Y be continued to 4 . Confequently, as we have fhewn before, the Part 2 of the Superficies of the Water in the upper Ciftern A B CD, will be prefs'd downwards by the Column of Air W 2 .

Let us again call the Weight of the faid Column $a$, or 1000 Pounds.

After the fame manner we will term the Weight of the Water-Column R 2, $b$, or 100 Pounds; as alfo that of the Air-Column T 3, c or 10 Pounds too: The fecond Water-Column Y Z fhall be exprefs'd by $d$, or 80 Pounds, and the fecond Air-Column ${ }_{4} \mathrm{M}$ by $e$, or 8 Pounds.

To proceed then.
The Part R of the Horizontal Plane $\mathrm{R}_{3}$ is prefs'd downwards under the Tube NR by the Weight of the Air-Column W 2, or $a$, otherwife 1000 Pounds joyntly with that of the Water-Column 2 R, otherwife $b$, or 100 Pounds; and confequently by $a$ and $b$ together, or by 1 rov Pounds.

But all Things being quiefcent, we know according to the foregoing Sect. XLIII. that with

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the fame Force as R is prefs'd downwards, the equal Part 3 is prefs'd upwards; fo that the Force which drives the Part 3 upwards, is likewife equal to $a$ added to $b$, or 1 roo Pounds together.

Now the Air-Column T 3 nam'd $c$, and fuppos'd to be io Pounds, does alfo gravitate with the fame Force upon 3 downwards. Wherefore Subftracting this downward-preffing Weight $c$, or 1o Pounds, from the Force that preffes 3 upwards, or from $a$ and $b$, that is inoo Pounds, the Force with which the whole Air-Column T 3, and confequently alfo its Superficies. T, by the Difference of both thefe acting Powers is moved upwards, does refult from thence. And the fame muft be exprefs'd by $a$ and $b$ together, lefs $c$; or by 1100 lefs 10 , that is by 1090 Pounds.

Again, fince T is a Part of the Air's lowermoft Horizontal Plane T Y, which Air prefles upon the Water in this Ciftern DCK I, and fince Y is an equal Part of the faid lowermoft Horizontal Plane, it follows according to the abovemention'd Laws of Hydroftatics, that $Y$ is prefs'd with as much Force downwards as T upwards; fo that Y is prefs'd downwards with a Force equal to the faid $a$ and $b$ together, lefs $c$, or with 1090 Pounds.

To which if we here add the Weight of the fecond Water-Column Y Z, that is, of $d$, or 80 Pounds, the Part $Z_{9}$ will be prefs'd more ftrongly downwards with this Weight than the Part Y; and confequently the Weight which preffes $\mathrm{Z}_{9}$ downwards, will be equal to $a, b$ and $d$ together: lefs $c$, or 1000,100 , and So together, lefs 10 ; that is, 1170 Pounds.

And fince $\mathbb{Z}_{9}$ and MO are equal Parts of the Horizontal Plane Z O, M O, prefs'd with the fame Force upwards.

If now the Cock at MO had no confiderable hicknefs, and yet hinder'd the Water from fpringing oit, it would appear that M O were prefs'd downwards with the Force of the whole Air-Column M X, that is of X 4 , $a$, or 1000 Pounds (for this is equal to W2) and 4 M , e or 8 Pounds, that is, taking in all together, $\mathbf{M O}$ is prefs'd downwards by a and e together, or roo8Pounds.

And it has been fhewn before, that it is press'd upwards by $a, b$ and $d$ together, lefs $c$, or by I 70 Pounds.

Wherefore if we fuffer thefe up and downwardpreffing Powers to operate on each other, as they do, when the Cock is open'd at MO; it is plain that the Water which preffes upwards at MO being ftrongeft, will over-ballance the oppofite Power that preffes the faid MO downwards, and be driven upwards by the difference of the Powers acting againft each other.

This Difference is found by Subftracting the fmalleft downward-preffing Force $a$ and $e$ together, or 1008 Pounds, from the greateft $a, b$ and $d$ together, lefs $c$, or 1170 Pounds.

So that the Difference, or the Force wherewith the Water afcends at MO, is equal to $b$ and $d$, lefs $c$ and lefs $e$, or to 162 Pounds.

Or to exprefs the fame by Words that may be apply'd to the Fountain, and to take thefe Things for the Letters which they denote: The Water will be protruded out of the Cock MO with a Force equal to the Weight of both the Water-Columns 2 R and $Y Z$, Subftracting the Gravity of the two Air-Columns T 3 and 4 M .

Now fince the Weight of the Air with Refpect to that of Water, is as $\frac{\mathrm{s}}{1000}$, it may be omitted in this Calculation, as making no confiderable Alteration therein. And we may advance, without committing any Miftake worth notice, Nnn4
that
that this Fountain fpouts with as much Force, as if the gravitating Water in the Ciftern had the Height of both the Water-Columns 2 Rand $Y Z$, that is, of $b$ and $d$ placed one upon the other.

So that from hence it is eafie to infer, why the Stream M V fprings much higher than the higheft Water $A_{2}$ in the Ciftern, fince the Height thereof alone is equal to that of a Water-Column 2 R in this Contrivance of a Fountain. And that Experience agrees with thefe Propofitions, every Body that pleafes to try, will find as weil as we.

Sect. LII. Of a Fountain of Hero, the Stream whereof is longer than the Fountain bigh.
LIV. Some Years ago, I caus'd to be made another kind of a Table-Fountain, of the Nature of that Hero Alexandrinus; but with this Difference, that whereas in that of Hero it is not poffible to make the Stream that fpouts out to attain to the Height equal to that of the Fall of the Water, or of the Fountain itfelf; yet in mine, notwithitanding the Height of the Machine, was no more than $3^{\frac{2}{2}}$ Foot, the Jet rofe ftrongly five Foot higher than the Water in the upper Ciltern.

The Structure is thus: G A F H (Tab. XXVIII. Fig.3.) is the uppermoft Ciftern, being open, and having under it two fmaller, and every where Air-tight Cifterns A BCD, and DCE F; each of thefe has an Orifice or Hole, one at M, t'other at N , and both of 'em may be render'd alfo Airtight, by foopping them with a Cork cover'd with a wet Bladder, or a Cock. There are likewife rwo clofe Cifterns below, STRP, and PRQO. From the Dortom A F of the uppermof Ciftern GAFH, there paffes a Tube K I downwards almoft to the Bottom R.T of the $\mathrm{Ci}-$
ftern P R T S; but in fuch a manner that the fame, or whatever it contains, has no Communication with the Ciftern D C E F through which it paffes. And from 3 in PS, there is carried a Tube 3 L upwards, juft below the uppermoft Plane DF of the Ciftern DCEF; from the Bottom of which CE, there defcends again at 9 a Tube at $9 b$, terminating in the other Ciftern Q O PR very near the Bottom of it QR. And this fame Cittern QOPR fends again a Tube 4 Zupwards, which beginning at 4 is carried on to Z , exactly under the uppermof Plane $A \mathrm{D}$ of the Ciftern ABCD. Laftly, At A D there is a Tube $p r$ clofe folder'd at 56 , which rifes to $r b$ only, or a very little higher than the Plane A D ; and paffes downwards to $P$, or nearer to the Botton B C.

On the Top of this laft Tube, we fix'd another $r 8$, which at $W 8$ was cover'd with a flat Plate, having a fmall round Hole in the Middle of it, thro' which the Stream was to pafs, and we clos'd it at the Joint $r$ with Emplaftr. de Minio, fo that it was impervious either to Water or Air.

Now to fet this Machine to Work :
We inverted or turn'd it upfide down, fo that the Ciftern GAFH was undermoft, and having fill'd both the Cifterns A B CD, and DCEF with Water at the Orifices $M$ and $N$, we ftopt the faid Orifices very clofe with a Cork and Bladder, putting a Finger in the mean time upon the Hole in the little Plate W 8, to the end that the Water pour'd in at M , or fo much of it was above $p$, might not run out.

Then fuddenly placing the whole Machine in its former State, fo as that the Ciftern G A F H was again uppermoft, we pour'd without delay fome Water that was at hand in the faid Ci -
ftern; whereupon, prefently afterwards, we faw a Stream 87 rifing out of the Tube $r 8$ thro' the little Hole, which Stream when meafur'd was much longer than the Height of the whole Machine, as has been already faid.

It will not be neceflary to give an Account here, how the Water fubfiding, or finking from GAFH thro' the Tube K I prefles the Air out of the Ciftern P R S T thro' the Tube 3 Lupwards, which finding no room any where but by preffing downwards the Water in the Ciftern DCEF, and in the Tube $\mathrm{Y} h$, protrudes the faid Water towards the Ciftern O QR P with a much greater Force than that of its own or fingle Gravity. At which Place the Water likewife afcending, the Air is protruded with the fame Force from O QR P thro' ${ }_{4}$ Z to the Ciftern ABCD, which (without counting, the Air in the Tubes $\mathrm{L} g$ and $\mathrm{Z} v$ becaufe of its Levity, and fmall Refiftance) caufes the Water to fpring out of the Tube $p 8$; after this manner with almoft the Force of both the Weights of the Water-Columns Y $b$ and K I. In the fame manner we may deduce the Operations of the foregoing Fountains, Syphons and others, whereby, without any Calculation, we may alfo Form a general Idea of their Proverties. I thought it fufficient to give my Readers one only Inftance here, it not being my Defign to write an entire Syfem of Hydroftatics. They who would impute the Force wherewith the Water iffues out of the Fountain exactly, may do it after the Method of the aforemention'd Examples.

But before I procced any further, I muft add, that this Machine may be form'd after a much more convenient manner, fo as that one need not invert it, nor yet flop the little Hole of the Column W 8 with the Finger, or any thing elfe; this may be done by Stop-Cocks in other Places ${ }_{3}$

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and by making the Orifices M N above at A F, as is known to every Body that has any Skill in thefe and other kinds of Water-Works. Yet I have rather chofe to exprefs it in the prefent manner, becaufe it is that in which I made the Experiment, and in a Piace where we could form this whole Structure of no other Metal than Tin, nor could have the Affiftance of fuch Workmen as are neceffary in fuch Matters. Whereas the other Fountain was prepar'd by a Perfon of good. Judgment, and who was well inftructed concerning the Frame and Make thereof.

Nor will it bedifficult to one that rightly underftands this, and the foregoing Difpofition of a Fountain, to caufe a Stream of Water to rife up to a given Height by a requifite Multiplication of Cifterns and Tubes, the Height of the Defcent of Water being likewife given. I It is certain at leaft, that all this may be deduced by Argumentation, and confirmed by Experience.

Sect. LIII. The Motion of Water in a Curve Tube.
LV. In the laft Place we fhall add fomething, which, tho' of little Importance, yet at firlt Sight has appear'd wonderful even to fome Mathematicians themfelves, to whom we have feveral times communicated it ; and which ferves to confirm the foregoing Laws after a ftrong manner.

Y $m n$ Z is a Ciftern or broad Veffel (Tab. XXVIII. Fig. 4.) fill'd with Water up to the Brim ; PO NM is a Cylindrical Glafs, with the Bottom P O upwards, and the Mouth M N juft under the Surface of the Water in the Ciftern, and containing before it was inverted, fome Water in it, which (the Mouth of the Glafs being thus turn'd downwards, continued fufpended therein at the Height QR.

Moreover L B V is a Curve Tube, both Legs of which being fill'd with Water to the fame Height $\mathbf{L}$ and $r$, I put my Mouth to the Orifice V, and blow'd it back from $r$ to A, thereby caufing it to run out at L .

The Water by this means being contain'd between L and A , to prevent its fubfiding at L , and rifing at $A$; $I$ prefently fopt the Orifice $V$ with my Finger, whereby the Water remain'd fo much lower at A than at L .

Then I put the faid Tube LBA under the Glafs MNOP, fo that a Column TL of Water, (and the Glass being not quite full) a Column alfo of Air $u \mathrm{~T}$ was above the Orifice L.

Thus the Water being at unequal Heights in the Tube, under the Glafs, and in the Ciftern; (forafmuch as that in the Leg of the Tube L B, was not oniy the entire Length SL or Ar higher than in the other $\operatorname{Arm} h \mathrm{~V}$; and befides the Water-Column T L prefs'd yet more upon the Orifice L, without counting all the Air $\mathrm{T} u$,) Who could at firft fight, unlers he were weil vers'd in Hydrofatics, imagine otherwife, than that by the greater Height of Water, at S L, or rather at S T, the Water would be forced upwards at A, when the Finger was remov'd from $V$.

And yet we find by Experience, that inftead of A rifing to $r$, the Water will fubfide from A to F, as foon as ever the Finger is taken from $V$.

To difcover therefore the Reafon this Phenomenon, fo furprizing to fome People, nothing more is neceffary than to trace the fame back to the before-eftablifh'd Laws of Fluids, when you have again blown the Water down to A, and fop'd the Orifice $V$, and reduced all to its former State.

Let us then again fuppofe W X to be the upper Superficies, and AE a Horizontal Line drawn parallel
parallel to Y Z. Now let the Air-Column W E equal to X A (the Finger being remov'd from V) be each call'd $a$, and the little Water-Column A F becall'd $b$; and the little Air-Column G E of the fame Height with AF, be $c$; each of the Water-Columns Hg and D T be $d$; and the little equal Air-Columns $t g$ and $u$ T be $e$ : Whereby, according to the foregoing. Method, the Force may be computed with which the little WaterColumn AF is prefs'd down to F, or to the Depth Y Z.

But this may be likewife more briefly done after the following manner : The Part $G$ is prefs'd by the Air-Columns W E and E G, or by $a$ and c; but (according to SecZ. XLIII.) the Part F lying in the fame Horizontal Plane Y Z, is prefs'd upwards with the fame Force $a$ and $c$, when upon ftopping the Orifice $V$ with the Finger, all is ftill; forafmuch as there can be drawn a Thread from G to F, without paffing thro' any other Solid or Fluid Matter : But if now you remove the Finger from $V$, the Part will be prefs'd down by the Air-Column X A $a$, and the little Water-Column A F, $b$; fo that the Force which preffes F upwards, is $a$ added to $c$, that which preffes the fame downwards is $a$ added to $b$.

Now fince $b$ is Water, and $c$ Air, the downwardpreffing Force upon F, or $a$ added to $b$, is greater than theForce preffing upward exprefs'd by $a$ and $c$; andconfequently the Part F is prefs'ddownwards by the Difference of this Force, or by the Force of Gravity where with the little Water-Column exceeds the equal Air-Column E G, that is by $b$ lefs $c$.

From whence it appears, that whilit A F or b is Water, and heavier than G E or $c$, which is Air, the Part F, and confequently the Column AF, will be prefs'd or move downwards, and ne-
ver ceafe till A fubfides to $F$, and the Column
A F becomes Air likewife.
And then the Difference of AF and GE, or $b$ lefs $c$ will be nothing, and the Force preffing up and downwards upon $\mathbf{F}$, equal; for which Reafon the Water in the Tube $\mathrm{V} b$ will not be higher than at $F$, or equal to $\mathrm{Y} Z$, when all is quiefcent by its Weight only. And the fame is conformable to Experience.

We might here fubjoyn the Demonftration, that if L the Orifice of the Tube L B V ftood out at any Height above the Water QR in the Air P Q OR, the Water would not fubfide folow as For YZ, but that it would remain and reft proportionably as much higher above F or $\mathrm{Y} Z$, as $L$ fhould be above QR.

I cannot forbear thewing here, how neceffary the laft Obfervation made (Sect. XLIII.) is in this Calculation ; to wit, that fince the Orifice $L$ of the Tube LB $V$, being under the Water at $Q R$, a Thread can be drawn from $G$ to $F$, that pafles thro' no other fluid Matter than this Water; we may prefently difcover after a much fhorter manner the Preflure upwards of F, by the Preffure downwards of $G$.

But when the Mouth L of the Tube L B V happens to be above the Water $Q R$, in the Air PQOR, we fhall find that the Thread which we would have drawn from $G$ to $F$, mult firf pafs thro' the Air P QR O out of the Water to the Orifice L, before it reaches F; for which Reafon the aforefaid fhort or abridg'd Computation can't be made true, fince, for this Reafon, $F$ and G will not be prefs'd with equal Force upwards and downwards, the Finger being upon V, tho ${ }^{\text {s }}$ they be equal Parts of the fame Horizontal Plane. This will appear clearly to every one that fhall
compute it after the manner of thofe Examples mention'd, Sect. LX, and LXI.

But this may fuffice to give a fhort experimental Example of thefe Laws of Hydroftatics.

This Experiment may be made with little Trouble or Charge, if you put a Curve Glafs Tube in an Ounce Viol almoft full of Water, adapted to the Mouth of the Viol, that no Water can run out of it when inverted, or turn'd upfide down.

## Sect. LIV, LV, LVI A Hydrofatical Paradox Bown by two Experiments.

LVI. No w that thefe many thoufand Parts of which Fluids confift, how ignorant foever of what they are doing, obferve fo accurately thefe Laws of Height, that before they depart from them, they produce Effeets incredible to many Perfons, will appear from what follows.

Let (Tab. XXVIII. Fig. 5.) D C be a round ftreight Tube, of as great a Length and Breadth as you pleafe, in which two other Tubes A C and B C do open, or even as many more Tubes as the Circumference of the firft Tube D C will contain, and thefe alfo may be as large as you will; but for the fake of Plainnefs, we will fuppofe there to be no more than three, and of equal bignefs.

Then fill all thefe Tubes with Water to an equal Height, which upon opening the Cocks G, E, F, will prefs upon the Bafe C of a Veffel of Communication C T H fitted to the Cocks and Tubes; and upon removing that Bafe or Bottom woul'd run out thro' C .

Now according to the foregoing Laws, it is obvious to all that underftand Hydroftatics, that, if all the Cocks G, E, F, be hut, and upon open-
ing any one of them, the Water contain'd in each of thefe Tubes feverally will prefs on the Bottom C with the fame Weight ; and that therefore if the Water in D C only (fuppofing the Cock E open, and G and F fhut) prefles on the Bottom C with the Weight of 100 Pounds, the Water in the Tube A C only (the Cock G being open, and EF fhut) will prefs the bottom $C$ with the fame Weight of 100 Pounds; and fo likewife will the Water in the Tube BC.

Now fince the Water in each of thefe Tubes does alone, and without the Weight of the other two, prefs upon the Bafe C with $\mathbf{1 0 0}$ Pounds; let one who has never feen thefe Hydrofatical Experiments, nor heard of 'em, ask himfelf with what, or how much Weight all the Water in the three Tubes acting jointly, and the three Cocks being open, will prefs upon the Bafe C ; and let him tell us, whether he do not find himfelf at firft difpos'd to anfwer (as I have known many learned and ingenious Men do) that fince the Water in each fingle Tube preffes upon C with I oo Pounds, all three of 'em operating together, will prefs with thrice the Weight, excepting the little Water at T HFEG, which lies between the Cocks and the Bottom C, and always remains the fame ; which however, if the Tubes be taken long enough, makes no remarkable Difference.

But in cafe we fhould tell him : Fir $\ell$, That far from anfwering rightly, he has quite miftaken the Matter ; and that altho the Water in each of thefe Tubes does fingly prefs upon the Bottom C with the full Weight of roo Pounds; yet when all three of 'em at upon the faid $C$ together, the Preffure is no more than of 100 Pounds, even though the Tubes were larger, and more numerous, and confequently contain'd in them a greater Weight of

Water;

Water; for Inftance, if each Tube like NBF were of the Size and Figure of NF R, or any other; provided only that the Water in each of the Tubes fhould continue at the fame Perpendicular Height D H, or R S, and the Bafe which bears the Preffure, of the fame Extent.

And Secondly, that the fame happen'd by virtue of the aforemention'd Hydroftatical Law, that no Part, as T H, of a Horizontal Plane T S, does ever bear a greater Burden than the Weight of the Column of Altitude, which has T H for its Bafis, and DH or RS for its perpendicular Height: He will fee indeed that this is a juft Conrequence of this Law ; but undoubtediy alfo confefs, that the manner after which the Water muft be difpos'd in thefe three or more Tubes, fo as not to gravitate more with a triple or greater quantity of Water, than with one third thereof, is unknown to him.

The rather, fince he fees that fuch Preffure is perform'd not by a Fluid actually put in Motion, but by a quiefcent one.
LVII. And to the end, that they who read this, fhould not doubt of the Truth of the Experiment, which, unlefs they were thoroughly vers'd in Hydrofatics, they could hardly avoid, let them pleafe to compare the following Experiments therewith, which are only made to fupport the Truth of the former againft thofe who queftion it. I find them thus defcrib'd among the Experiments which I noted fome Years fince on my Journal.

I caus'd a Machine to be made after the following manner: M N Q R (Tab.XXVIII. Fig. 6.) is a Tin Tube having a Cock at K , which can fop and open the Communication between the upper and lower Part of the Tube. From this Tube

Vot. III.
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at $S$, there rifes another oblique one T S , growing wider and wider to the Top O T P, after the manner of a Funnel, having likewife a Cock at $\mathbf{L}$, which can open and flhut a Paffage between the Fluid that is above and below it ; at the end of this tin Tube at QR, there is another Glafs one, CRGH ftuck into the former, and both clos'd together with Empl. Diachylon.
Then I took a large Cylindrical Glafs A E F B; and fill'd it up to C D with a ftrong Pickle, and binding the tin Tube together with the glafs one, faft to a tranfverfal Picce of Wood XV ; being empty, I let them down into the Pickle to a certain Depth.
Whereupon pouring gently fome Oyl of Turpentine into the Funnel and Tube (both Cocks being open) after that a part of it ran out at GH, and produced a Cream of floating Oyl upon the Pickle at A B C D, we found that the faid Oyl being lighter, and confequently kept up by the Weight of the Pickle, at M N OP, for Inftance, or at leaft much above the Superficies of the Pickle, remain'd in that Condition in the faid Funnel and Tabe.
Having then ftay'd ti: 1 all was perfectly ftill, we obferv'd a drop of Oyl hanging below at the Bottom of the Glals Tube G H, which immedi--ately, upon poiring fome little quantity of Oy 1 into the Funnel at O, or the Tube at N, by fuch a fmall acceffion of Preffure fell off from GH , and emerged in the Pickle. After which (the piece of Wood V X being ty'd very clofe to the Glars Vefiel, that it might not ftir) when another Drop of Oyl was hanging at GH , we foftly turn'd both the Cocks at K and L , and made them faft; and then found that whether one or both of ${ }^{3} \mathrm{em}$ were open'd, the Preflure was not fo much alter'd, as to caure this furpended Drop of Oyl to fall off;
tho' we had feen before, that it always fo happend by the addition of a frall Weight, which was not to be compar'd to that of the Oylin the Funnel.

From whence (not to recapitulate all the Confequences deducible from the many Hydrofatical Laws which we have before laid down and proved) it appear'd that the Preffure of the Oyl in the Tube N'H, was neither increas'd nor diminifh'd ; wherher it was that the Preffure of all the Oyl which was in the Funnel S P O, acted and preffed downwards, or whether it was hinder'd from doing fo by the Cock L .
LVIII. For the fame Purpofe we joyn'd a Curve Tin Tube DEF, to the preceding Inftrument BCD, and fticking into it a Glafs Tube F A, clos'd 'em together as before at D and F. Then the Cocks being open, we pour'd commonWa= ter into the Funnel C, till it rofe to the fame Height ABC in the faid Funnel, and both the Tubes $A$ and $B$ : And moreover having open'd and fhut each of the Cocks $K$ and $L$, and afterwards both together, we could not obferve the leaft finking or rifing at A ; fo that it alfo appear ${ }^{3} \mathrm{~d}$ from hence, that the Preffure of the Water in the Tube $B \mathrm{D}$, whereby the Water in E F was fultain'd at the Height A, and did neither increafe nor diminifh; but continued entirely unalterable, whether the Water in the Funnel gravitated on it downwards ornot.

From both which Experiments, what is faid above in Sect. XLIV, feems to be fufficiently confirm'd, as ftrange as it may otherwife appear to any one at the firft Sight, altho' it be obvious enough to fuch as underftand Hydrofatics.
LIX. Another Inftance concerning which, even the greateft Mathematicians freely own their Ignorance (or at leaft their Uncertainty) as far as relates to the Manner of the Water's working : We will here offer, not according to the little Meafure of the Infruments wherewith we perform'd it, but as in the former, fo as to render it more Intelligible, and to make a greater Impreffion.

Let A B L M (Tab. XXIX. Fig. i.) be a Veffel reprefented here in its Profil or Section; and for the fake of Perfpicuity fuppos'd exactly Square, and the Dimenfions of its Length and Breadth to be 12 Foot: This Veffel muft likewife be fuppofed to be fhut clofe with a flat Horizontal Cover--ing A B, of the fame Breadth, having at VR a leffer fquare Orifice, in Length and Breadth 2 Inches, or $\frac{1}{\approx}$ of a Foot, from whence there rifes a fquare perpendicular Tube R QSV, of the fame Breadth and Widenefs with the little Hole V R, but its Height QR of 36 Foot; let the Height of the Veffel W A be eight Inches or $\frac{2}{5}$ of a Foot.

Below, at W Z, the Ciftern ABW Z is quite open, but there is a loofe wooden Bottom Frame lying upon the Brim of the Ciftern M N, LO, tolerably ftrong and inflexible, and fo placed, that when the Water is at any height, nothing can pais between the Frame and the faid Bottom. We had put under a much fmaller Bottom, which we had ufed for this Purpofe, a thick wet Piece of Leather, which lay upon the Points of the upwards-bent Tin Brim O and N, and which by the Gravitation of the Water upon the wooden
den Brim being prefs'd downwards, kept the Water intirely in the Ciftern.

There was befides a Ring faften'd at $E$ in this Bottom, from which a String paffing thro' the fquare Tube, was ty'd above at $F$, to one end of the Ballance H G F ; fo that by drawing the faid String, F E upwards, the faid Bottom W Z could be rais'd up at the fame time.

Then pouring Water into the Ciftern A B Z W, up to the Brim A B, it is plain that the Length and Breadth of the faid Ciftern being 12 Foot, the Area thereof will contain 144 Foot, which being multiply'd by the Height A B or $\frac{2}{3}$ of a Foot, or 8 Inches, the folid Contents of this Ciftern, or of the Water in it, will give 96 Cubical Feet, weighing (if you allow 63 Pounds to a Cubical Foot of Water) 6048 Pounds.
Wherefore theWeight $I$, equal to fo many Pounds, being put into the Scales fufpended at H , the fame (if you except the Weight of the Bottom W Z, and the Frition befides) will equiponderate the Water in the Ciftern A B W Z ; and if it were but little more augmented, it would be able to raife the Bottom W Z with all its Water A B, tho neither the Cover or Lid A. B, nor the Tube R QSV, were over the fame. And this whole Matter is obvious to every Body.

But if we proceed farther, and do alfo fill the faid Tube with Water, which Tube being 2 Inches or: of a Foot Wide, and 36 Feet in Length, it will exactly contain a cubical Foot, or 63 Pounds of Water, according to the foregoing Suppofition.

This being done, fince the loofe Bottom W Z. may be here confider'd as a Scale fufpended to the Ballance F H at E, upon which the Water in the Ciftern A Z, and in the Tube $Q R$, weighs againit the Weight put into the other Scale fufpen0003 ded
ded at H ; let any one that has not nicely oblerv²d thefe Singularities in Hydroftatics, or been Converfant in thefe Matters, I fay, let fuch a Man retire, and ferioully Reflect with himfelf, that, forafmuch as the Weight I is in Equilibrio with the Water in the Ciftern A BWZ (exclufive of the Cover A B, and the Tube R Q); and fince the whole Tube QR does alone contain a cubical Foot, or 63 Pounds, of Water; whether he might not fafely enough conclude, that the Weight I being augmented by another Weight W, weighing confiderably more than the faid cubical Foot of Water; for Inflance, by adding 100, yea even rooo Pounds thereto, the loofe Bottom W Z, or the other Scale with the Water upon it, might be very eafly taifed up; the rather, fince the fame is found to hold true in all folid Bodies, and even in Water itflf, if turn'd into Ice, provided it were not frozen to the Sides of the Ciftern or Tube; as is affirm'd by Monfieur Varignon, in the $A \not Z_{\text {. }}$ Lipf. 1692. p. 365 .

But he that has read and confider'd the above-fhown Laws of Hydroftatics, will fee (Sect. XXXVIII.) that in the Horizontal Water-Plane A B, juft below the Cover of the Ciftern A B, the Plane V R is prefs'd by a cubical Foot of Water, or 63 Pounds; for which Reafon every equal Part $\mathrm{R} e$, ef, and $V m, m n$, of the faid Horizontal Plane, according to the faid Law, (Sect. XXXVIII.) the Water being quiefcent in the Tube and Ciftern) will be prefs'd downwards equally in all its Parts ; fo that therefore this one Foot of Water, or 63 Pounds, in the Tube QR, does equally gravitate on the loofe Bottom W Z, as all that quantity of Water that would enter into the Cavity A B T P, in cafe the Ciftern A W Z B were a perpendicular fquare Veffel

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Veffel of 36 Foot in Depth or Height, and 12 Foot in Length and Breadth.

Now we may difcover the Weight which this Water would amount to, by multiplying firf the Breadth and Length of the Ciftern, or 12 Foot, by each other, whereby the Area or Bafe will contain 144 fquare Feet. This being again multiply'd by the Height Q R or 36 Feer, makes the folid Contents of the Veffel A BTP, 5184 cubical Feet; each of which being again fuppos'd 63 Pounds, the whole Mais of Water will weigh 326592 Pounds : With which Weight the loofe Bottom W Z is burden'd and prefs'd downwards by the little Water in the Tube QR.

Wherefore far from raifing the Bottom W Z by adding another Weight W (of 100 or 1000 Pounds either) to the Weight I in the Scale hanging at $\mathbf{H}$, there wou'd be requir'd a Weight of above 326000 Pounds, only to equiponderate, or rather to put in Motion the 63 Pounds of Water thus difpos'd in the Tube QR.

And let no Body doubt of the Truth of what has been advanced, provided the Cittern be every where ftrong enough to withftand this terrible Preffure. The Matter is well known to all the Moderns skill'd in Hydroftatics, and has been Experimentally prov'd by many, as well as by us in fmaller Veffels.
LX. We don't only difcover thefe Wonders in the Preffure downwards of Fluids, but we Experience them too in the Preffure upwards thereof, according to the fame Laws; for fince VR is prefs'd downwards by 63 Pounds when the Tube Q R is full, according to Sect. XXXVIII, every equal Part ef, \&c. in the fame Horizontal Piane A B will be prefs'd upwards with as much Weight, and confequently the whole fquare OOO 4

Cover

Cover A B, will be rais'd up with the Force of 326500 Pounds, including the Orifice VR, and that which preffes on it.

We have a remarkable Example of the latter in Mr. Mariotte's Mouv. des. Eaux. p. ro6. He took a Tub A B C D, Tab. XXIX. Fig. 2. both Bottoms whercof AM D were bent inwards, and making a Hole in one at E, he placed in it the Tube EF of 1 Inch in Breadth, and 14 or 15 in Length, fo that no Air could pafs between the Tube and Hole; then filling the Tub with Water, he fet two Weights of 800 Pounds P Q uponit. After that he alfo fill'd the Tube with Water, and found that this laft fmall Quantity of Water did not only lift up the Lid or Bottom of the Tub together with the faid Weights, but likewife bent the faid Lid outwards; all which appear'd by a little Piece of Wood I L which was fet for a Mark, and which almoft touch'd the Tube at H ; the faid Mark at H being rais'd above I L by the faid Preffure upwards.

The End of the Experimental Demonftrati: ons, ofc.

Sect. LIX. Convictions from the furprifing Force of Water.

I Leayenow an Atheift to confider, whether this Law of Preffure according to the Depth, and therein the dreadful Force of fo fmall a quantity of Water, ought not to be look'd upon as Wonderful; and unlefs Experience had prov'd the Certainty of it, whether he could have thought it credible, and whether he would not have rejected the Principles from whence it is deduced ; and that he may fee what the greateft Mathematicians think thereof, let him confult the AEF. Lipf. 1692 p. 365 , and he will find that M. Varignor,
whom the whole World allows to be fo great a Mechanilt, gives it the Name of a famous Paradox; of the Truth of which he fays, the modern Mathematicians are fufficiently convinced; but that they differ about the Manner according to which the fame is produc'd by Fluids; and Mr.Mariotte calls it a furprijing Effect of the Equilibrium. Mr. Whifton Pralect. Phyf. Math. p. 247, fays of this Law (of which all thefe Wonders are plain Confequences) that it is a well-known Rule in Hydroftatics, but which has hardly yet been proved either Naturally or Mathematically ; concerning which he gives us his Opinions in Liquids really moved, but not in fuch as are fagnating; fo that all the appearing Wonders are not yet compleatly folved thereby.
At leaft it now feems, that no Atheift can come fo far without charging himfelf with Folly, as to imagine that he is capable of proving that the Works of Nature muft be caufed or produced by a blind Neceffity, which he is forc'd to own, he does not well underftand; and which far from appearing to him as neceffary, he muft look upon as impoffible, or abfolutely incredible, were it not that he was convinced thereof by Experience. And whether he can afcribe all thefeWonders (that are produced with fo much Conftancy and Regularity, that they plainly adapt themfelves to all the Confequences that can be deduced by the Mathematicians from preceding Laws) to meer Chance, I leave to him to confider.

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Sect. LX. ConviEtions upon another Foundation.
I Must add this in General hereto; that tho' many have endeavour'd to deduce both from the Laws of Mechanics, and particularly from the following: That in order to raife a Weight of a hundred Pound as high as one Foot, the fame Force is requifite, as to raife one Pound the the Height of a hundred Foot, at the fame time; concerning which Mariotte and other Mathematicians may be confulted; yet no Body has been able without Difficulty, to explain the Manner after which the Fluid Matters, even in reft, adapt themfelves to obey thefe Laws to produce fuch Wonders; and Mr. De la Hire (fee his Mechanique Prop. 106. p. 33 1) and Mr. Varignon have very ingenioufly invented a new kind of Levers, the Effects of which are fo very analogous to the Powers of the Fluids, that being fhut up into a fquare Box or Cheft, and put in order, gravitated or prefs'd againft its Cover, Bottom, and Sides, after the fame manner, as if the faid Box were fill'd with Water ; but how gieat an Analogy foever may be proved from hence with Fluid Marters, neither thofe Gentlemen, nor any Body elfe, can eafily be perfwaded that Water, Oyl, or any other Liquids, owe their aforemention'd Motions to the like Machine.

Sect. LXI. Without the Laws of Fluids, all Ibings would Soon be in the utmoft Confufion.

IN order to be convinced of that which happens in the World by this Law of Preffure according to the Depth, let the Philofopher who deduduces every Thing from mere Chance, or a natutal Neceffity, attend to the following Matters which
which he may have already found to be true from the Premifes, or if he be an experienced Mathematician, has been already affured of it by his own Study and Experience. -

Certainly he will not be able to contradiat this, namely, that all the Chambers of Houfes, from the meaneft Cottages, to the Royal Palaces, would be nothing elfe but fatal Caverns and a heap of Rubbinh to all that dwell it them, in cafe the Air fhould exert its Gravitation and Preffure, not like a fluid Matter, bat like a Heap of fmall folid Bodies, and confequently that there were no other than a perpendicular Preflure, without any Confideration or Effect of the Law of Preffure according to the Depth; whereby all the like Parts in the Came Horizontal Plane are preffed alike, whether the perpendicular Column of Air be great or fmall, quite otherwife than what happens in accumulated folid Bodies. Let it be then confider'd, what Confufion and Mifery would be hereby occafion'd to all Creatures that want a Shelter againft the Inclemency of the Air, fuch as Cold, Wind, Rain, óc.

To reprefent this yet more plainly, let it be fuppofed that fome Body is fitting in a Chamber W (Tab. XXIX. Fig. 3.) and is cover'd with a Ceiling thereof ABC , the Height of which from his Mouth by which he breathes, is as MO ; and the Height of the external Column of Air which has a Communication with that in the Chamber, is as QS. If now there were no greater preffure of the Air at LM, than from that Column thereof which is here reprefented by LNOM, (as it wonld happen if the Air gravitated like folid Matters) the Preffure thereof would be very fmall, and confequently the Elaficity, as foon as the Air fhould be rarified by
the removal of the Preflure to which it is ufed to accommodate itfelf.

For fince the Mercury in the Barometer T, is ufually rais'd to $28,29,30$, or 31 Inches, by the external Air P QS R, which Mercury is fourteen times heavier than Water; if we fuppofe the Height of the Mercury to be 30 Inches, there will be required fourteen times 30 , that is, 420 Inches of Water to balance the Air; and fince Water is commonly found to be 800,900 , or 1000 times heavier than Air (fuppofing this laft Sum to be trueft) the Air being compreffed in the fame manner as it ufually is with us, the Height of it will be 1000 times 420 , or 420,000 Inches (for we take no notice here of that greater Height which it may have upwards, becaufe of the leffer Weight it bears, and confequently is more expanded) and then we muft fuppofe QS to reprefent the aforefaid Height.

For Conveniency fake, let us now fuppofe N O to be the Height of 14 Foot, that is 168 Inches; accordingly the Depth of the Chamber A D or B K muft be computed at the rate of 18 or 19 Foot at leaft, which ishigher than common Chambers are ufed to be; and the Preffure of the Air at L M, which is the Weight of the aforefaid Column of Air L M O N of 14 Foot or 168 Inches, Is to the Preffure of the external Air P Q, As the Column L MON, Is to the Column PQRS; or As 168 To 420,000 Inches, or juft As I To 2500 .

Confequently the Preflure at L M within the Chamber, is only as ${ }_{2}^{5} 500$ Part of that which happens at $P Q$ by the Air out of the Chamber. Now this laft raifes the Mercury in a Barometer up to 30 Inches, according to which the Air in the Chamber at L M, would only raife the faid Mer-

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curyup to $\frac{1}{2020}$ or fcarce $\sum_{8}^{2}$ Part of an Inch, or abour $\frac{2}{5}$ of a Line which is $\frac{1}{2} \frac{1}{2}$ of an Inch.

This being fuppofed, every one that ever faw a living Creature put under the Receiver of an Air-Pump, near which a Barometer was likewife placed, has been convinced with the utmoft certainty, that long before the Mercury fubfided down to $\frac{1}{5}$ of a Line, that Creature would fall into Convulfions, and for the moft part expire too.

So that from hence, and other Experiments made by the Air-Pump (one of which we have quoted above in the XVIIth Contemplation from Mr. Otho Gueric, which had almoft coft a Man his Life) it is plain enough, that if the Air in the Chamber at LM, bears no greater Preffure than that which happens to it from the Height of the Cieling ON, all the Creatures that live either upon the Earth, or in the Air, would immediately die in the faid Chamber. And that all Chambers and Houfes would therefore be ufclefs, were it not alone that this great Inconvenience is prevented by the aforefaid Law of Prefure, every way according to the Depth of the Fluid, to which all fluid Matters obey, and by which the Preffure in the fame Horizontal Plane P M is equally ftrong upon the like Parts P Q and L M, whether within or without the Room.
For the fame Reafon it would not be poffible that a Ship could go under a Bridge without occafioning a fudden Death to all that were therein. No Fifh could even fwim under a Bridge without being in danger of lofing its Life, becaufe the Air that is under a Bridge, would gravitate much tefs upon the Water ; juft as it happens to fuch Fifh that are put into the Air-Pump, when the Air is beginning to be exhaufted from thence, when the Rarefaction of the Air, and the Diminution them into Convulfions, and foon after kills them; that the fame does not likewife happen under every Bridge, is aloneowing to the Laws of Hydrofatics.

To this may be added, that the Air at L M in a Chamber undergoing fo fmall a Preffure, that it can hardly keep up the Mercury in the Barometer to $\frac{1}{5}$ of a Line, wou'd become fothin, as to be uncapable of conveying Sounds to their Ears, of which we have already given Infances in the XVII Contemplation; fo that tho' one fhould be able to live in fuch an Air, yet no Man could fpeak to another therein : Not to mention that Fire will not burn in fuch a thin Air, nor Smoak afcend ; that none of the Particles which are the Object of Smelling, could pafs from any Bodies to us, befides many other Things which wou'd be occafion'd by the Thinnefs of the Air.

If againft this it fhould be objected, that altho' the Air in the Chamber undergoes fo little Preffure and Expanfion, yet the more compreffed Air would run thither from P QR S; as Water it feif would do, tho' there is little or no Elafticity in it, if it were in the place of the Air. To which we anfwer, that this Objection has no other Foundation but the very Action of Gravity, and the Law of Preffure, ofr. which is only peculiar to Fluids, which in this Cafe we do not fuppofe to obtain, fince we only endeavour to fhew what would happen if the Particles of Air operated by their Gravity, not like Fluid, but other folid Bodies.

To Illuffrate this Matter, let Tab. XXIX. Fig. 4. be a high Sand-bank (only confifting of folid Bodies for that Reafon) and of the Figure reprefented here by ABCDMHN; 'tis plain then, that the Body G is preffed with the Sand above

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 above it at E FCD, and if you will, with that on the fide of it at $Q R$; but if there be in the fame Horizontal Plane B H, another Body equally as big as $K$, which is no more than a Hands breadth L S below the Sand, every one knows, that this K bears a fmall Preffure, and much lef's than the Body G, tho' all the Sand were contained in a Veffel equal to the whole Circumference of the aforefaid Bank; and therefore that a Man that were at $G$ under this heavy Sand-Bank, would not be able to flir from thence, whereas if he were at K , he could raife himfelf with little Trouble.But now if infead of this Sand there were a Veffel of liquid Matter in the very faid Form, the Body K would be preffed with equal Gravity as G , in Confequence of the Law of Preflure. From whence it is manifeft, that if we rightly diftinguifh the Action of Solid from that of Fluid Bodies, this Objection will fall itfelf.
$\mathrm{S}_{\mathrm{EC}}$. LXII. Convictions from the foregoing Obfervations.

A t leaft, without infifting upon any farther Particulars, it will be unqueftionable to fuch as are verfed in the modern Natural Experiments, that without the Operation of this Law of Pref. fure, orc. in fluid Matters, Men would be entirely deprived of the ufe of their Houfes, and greateft Conveniences.

And this being fo, what Reward would not a Man have deferved that had invented a Method to hinder the fame, or that could have prefcribed fuch a Law to fluid Bodies? Would not every one, even an Atheift himfelf, think he was very much wronged, fuppofing he had only prevented all thefe Inconveniences after a much more imperfect manner, if inftead of returning him the

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Thanks that were fo juftly due to him, People fhould look upon him as an ignorant or foo.ifi Fellow.

Sect. LXIII. Even Lead it Self will foat upon the Water, by the Preffure thereof upwards.

But if we now turn our Eyes towards that wonderful Action of the Law of Preffure, \&c. namely, the Preffure of Fluids upwards; there will here likewife be vifibly manifefted the Glory, Power, and Goodnefs of the fupream Director.

Now that all Liquids which have others on the fide of them, do exert a real Force which preffes upwards, has been fhewn before, and may appear likewife from the Experiment of Mr. Boyle, which we fhall reprefent here below, after a cheap and eafie manner.

Could any Body who is unexperiencd in $\mathrm{Hy}^{-}$ drofatics eafily believe that a piece of Lead, which is fo much heavier than a like quantity of Water, fhould only by the Preflure thereof upwards, without being fupported by any other Matter, be kept floating and hinder'd from fubfiding? And yet we fee this happen, when there is no Water above the Lead, which by its Freffure might fink it down, and when the lateral Water is 13 or 14 times deeper than the thicknefs of the Lead.

They who defire to make an eafie Experiment thereof, may take a Tin Tube $d a b f$, (Tab. XXVI. Fig. r) the lower Orifice of which, $a b$, is fmooth and even; then taking a round piece of Lead a 6 mn , the thicknefs of which is about $\frac{1}{3}$ or $\frac{1}{4}$ of an Inch, and its Breadth ab fuch, as being laid upon the Mouth of the faid Tin Tube $a b$, may top the fame; let there be likewife a little Hook

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e, fixed as near as poffible in the middle of the Lead, and a String e $k$ tied to it. Then covering the Lead $a b$ with a little piece of Leather, or a wet Bladder with a Hole in the middle of it, to the end that the Hook and String may pafs through, you muft draw therewith the faid Lead A B N M pretey tight againft the Mouth $a b$ of the Tin Tube $a b d f$; then holding them thus together, let them down fuddenly into the Water to the Depth $d m$ (which is about thirteen or fourteen times as much as the Thicknefs of the Lead a $m$ ) in a large Veffel N T C O, in which the Water is at the Height of NO ; you will then find that the little String $e k$, and confequently the piece of Lead abnm being free, will not fink down at that place, but will be fupported by the Force of the Water preffing upwards, and perfectly fwim, according to the Experiments we have frequently made thereof.

Now that this happened only by the Preflure upwards, appears from hence; That if the Lead were not let down lower in the Water than about ten or eleven times its own Thicknefs, it would prefently, upon loofing the little String e $k$, fubfide; but being placed much deeper under the Water, we found, that both the Tube and the String itfelf being loofened, the Lead did not only not fubfide, but even the whole Apparatus was lifted upwards, rifing and finking like a piece of Wood.

The reafon whereof is clear enough, as well from what has been faid before, as from the Law of Preffure, \&cc. for fince the Lead is about twelve times as heavy as the like Quantity of Water when it is brought to be thirteen times deeper than its own Thicknefs a mbelow the Water NO O, and the Tube being held falt and ftill by the Hand, as the Lead is by the String, it is plain that the part

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$g h$ of the horizontal Plane is preffed down by the perpendicular Column $p q b g$; now this Column being thirteen times as high at $p g$ as the Lead $a m$ is thick, the Water $m n$, which is under the Lead, will prefs with the fame Force upwards; and fince the Lead is only able to prefs upon the faid Water $m n$ with no more than twelve of the thirteen parts, (it being but twelve times as heavy as a like Quantity of Water) it is plain enough that the faid Water is preffed upwards with thirteen, and downwards with but twelve parts; fo that the inferiour Preflure of the Water being greater than the fuperiour of the Lead, the faid Lead mult emerge, and cannot fubfide. From the faid Principles ir may be proved, why Lead, being let down into the Water but nine or ten times as deep as itfelf is thick, does on the contrary immediately fubfide, which is likewife always verify'd by the aforemention'd Experiment.

Of the aftonifhing Force wherewith this Preffure of Fluids upwards and downwards is brought to pafs, it will not be neceffary to fpeak now, af"ter what has been faid above in the XIXth Contemplation.

And from this Experiment, and from what has been flewed before about the finking of Wood, we may plainly enough conclude, that a piece of Wood, and much more the fmalleft Ship, would fink down like a Stone to the bottom, if it were not kept floating by the Preflure of the Water upwards.

## Sect. LXIV. Convictions from bence.

CAN now an unhappy Atheift fancy to himfelf, that this Force of the Water, whereby a Ship is caufed to float and fail upon the Sea (for want of which the World would be deprived of the greateft
greateft part of its Happinefs) is produced by Chance?

Shall we judge thofe to be wife and ingenious, and to have obliged the World, who have brought Ships and all their Tackling to that Perfection in which we now fee them? And can it be thought, that the caufing the fame to move round the whole Globe of the Earth, in a manner not to be comprehended by the greateft Mathematicians, and the making it to ride upon the back of a matter fluid, unftable, and yielding to the fmalleft Impreffion, could ever be brought to pafs, but by a Being infinitely more Wife and Good ?

And tho' the perpendicular, or downward Preffure feems in fome manner to refult from the Weight of Fluids; yet could ever any body have fufpected to have found therein this Law of the upward Preflure of Fluid Matters, had not the fame been demonftrated vifibly and experimentally? Is there not then a wife Difpofition requir'd here, and a directive Power extending itfelf to the fmalleft Particles in fluid Bodies, which ballancing them only by two equal Powers acting againft each other after a moft furprifing and unconceivable manner, even when they appear to us in an impotent Reft, and feem to be perfectly void of Action and Motion, compells them to ftand fill? What can one fee in the Water called the $\Upsilon$ before Amferdam, when it is not moved by any Wind, but has a Superficies as fmooth as Glafs, that can be compared with fo unconceivable and violent a Force, by which whole Fleets laden with Cannon and other heavy Burdens, are hindered merely by this Preffure upwards from finking down a Hair's Breadth. And can any one reflect upon what has been faid, and upon fuch an infinite number of Millions of Millions of Particles of Water, all compelled to obey
this Law, without difcovering therein a Wifdom and Power that far exceeds all human Underftanding? In which fo vifibly appear the great Deiigns of God in making the Seas and other Waters capable of bearing fuch mighty Burṭhens, at the fame time that they are compofed of a matter that may be feparated and exhaled by the fmalleft Force of the Sun, or any other Warmth, and drawn up into the Air, and turned into Clouds and Vapours.

SEcr. LXV. Lateral Preffure, and the Benefit thereof.
N ow as the Wonders of the Prefliure of Fluids upwards and downwards, are calculated to render Mankind happy, fo likewife may this fame Law of Preflure according to Depth (by which the lateral Prefiure is alfo regulated) ferve for a great Proof particularly, that without the fame the Sea would be unnavigable for Ships, and the Earth in a great meafure uninhabitable, fo that many well-peopled Countries would have nothing to expect but the utmoft Deftruction. Let it be fuppofed for Inflance (Tab. XXIX. Fig. 5.) that the Sea B C D E flands at the Height B C againft the Dyke ACMN; and firt that the Water being moved by no Winds, there lies a Ship fill at IFK, and at the fmall diftance B H from the Dyke : Now'tis plain, that if Fluids were governed by no other Laws than folid Bodies, the little Water at A HF being much lefs in Quantity, and therefore in Force and Gravity, the Ship would be thruft by the greater Quantity of SeaWater E GF, towards the Dyke A B ; according to which manner it would not be able to lie ftill in any part of the whole Sea, without being preffed by the heavieft and greatef Quantity of Water towards the fide of the fmalleft and lighteft.

We don't take any notice here of the Obliquity of fuch Preftures.

Now what Inconveniencies would occur from the failing upon the Sea and other Waters, if the fame fhould exert their Preffure not according to the fimple Laws of Depth, but like folid Bodies, according to their Quantity and Surface alfo?

But that which we now have chiefly in view is, what Dykes at A C M N would Men be obliged to make, if they were to be oppofed againft the lateral Preflure of the whole Sea C DE B, if the Force thereof were only regulated according to the Surface and Quantity of the Water that preffed upon the Dyke, as it happens in folid Bodies, had it not plealed the Director of all things to fubject the Force of this lateral Preffure fo ftrictly to the fingle Height or Depth of the Water, and not to its Breadth and Quantity ; infomuch that altho' the whole Sea fhould prefs againft one Dyke at B C, the faid Dyke would bear no greater Burthen than the Preflure of that little Water which (fuppofing. $C L$ to be equal to $B C$ ) could only be contained in the Space B C L, according to what we have already fhewn above?

## SEct. LXVI. Convictions from the fame.

Now can any one fee exerred fuch a Law of fo many Millions of fuch exceeding fmall Particles of which the raging Ocean is compofed, and which have not the leaft Knowledge of what they are doing, and yet act with fo much Nicenefs at all Times, and upon all Occafions; and cannot he therein difcover an over-ruling Wifdom and Power? The rather, fince this Law is the only Means by which fuch a dreadful Collection of Waters is hindered from overflowing the dry Land, whilft the Dykes refift their whole Force, fo that neither

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Men nor Beafts are overwhelm'd in the lower Grounds; of all which one cannot think without Emotion and Horrour, when one reflects upon the Weaknefs of the faid Dykes, with refpect to the unconceirab:e Weight and Quantity of the Water that preffes againft them.
If now any living Man had found out the Secret of obliging the whole Sea to fubmit itfelf to fuch Laws, that how vaft foever it was, but a very fmall part of it flouid prefs upon the Dykes, would not an Atheift ftand aftoniff'd at his Wifdom ? And if he had invented a Method, whereby not only all Waters, but likewife the whole Ocean of Air furrounding the Globe of the Earth, and all other fluid matters, even to the fmalleft Particle of them, could be bound and fubjected thereto; would not an Atheif be again obliged to confefs the unconceivable Extent of his Power?

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## CONTEMPLATION XXVII.

 Of fome Chymical Laws of Nature. Sect. I. Tranjution to otber Laws.AFTER having contemplated thofe Laws which have long been, and particularly of later Years are become the Objects of Mathematicians, let us now pafs on to another kind of Laws of Nature, which do not feem to be executed fo much by plain Percuffions or Strikings, as many of the firft, but according to other Rules (we fay feem, becaufe we acknowledge ourfelves
ignorant
ignorant of the manner thereof) by which Things being placed at a certain diftance from each other, are attracted (or at leaft do move) towards one another, without any vifible difcovery of Percuffion or Striking of other Parts there prefent; or elfe fuch, as being placed in certain Circumftances by or near other Bodies, are driven away or feparated from one another, to which Actions the Learned have annext the Terms of Attraction and Repulfion; to which Laws the Great Director has bound thofe Bodies that obey the fame, after a manner hitherto more wonderful than intelligible; and as the Naturalifts have difcovered the former Laws by Experiments, fo the Chymifts in a great meafure have found out thefe, which likewife have lately become the Objects of Mathematical Contemplations.

Sect. II. Experiments Shewing the Operation of Acids and Alcalies.

The great Phœnomenon of Nature, and which has given a handle to many Difputes and Argumentations of Chymifts and other Philofophers, is the famous Effects produced by Acids and Alcalies. By this laft is underfood every thing that ferments or boils up when mingled with foure Bodies, and afterwards is intimately united to the fame. Thofe who have never feen the Action refulting from the Mixture of Acids and Alcalies, would be wonderfally fupprifed thereat; and they may eafily make the Experiment, by putting in a little beaten Crabs-Eyes, which is the Alcali, into Vinegar, which is the Acid, and they will prefently fee the Effects thereof.

But the Motion will be much more violent, if one mixes the Filings of Iron with the Acid Spirit Ppp 4

To flew this Effervefcence in Liquids, we may take Spirit of Sal Armoniac mixed with melted Pot-Ab, or Salt of Tartar, in Water, and mix it with the Acid Spirit of Salt, Salt-Petre, or Vitriol, and we flall prefently difcover.a Arong Effervefcence between them.

SE ct. III. The aforefnid Salts are changed and united by Effervefences.

Now how many Effects refult from there Effervefcences, has been often flewie experimentally by the Chymifts.

It is a common Confequence, that after thefe Motions both the Acids and Alcalies lofe their former Properties, or at leaft do frequently feem to lofe them, fuch as their Tafte and Sharpnefs, and being clofely united to each other, do thereby produce a third Conftitution entirely different from each of the former, fuch as what the Chymifts call a Sal Salum, Enixum, Muriaticum, Neutrum or Mixtum, or as we call them in our Language, a fatiated, a Pickle-Salt, or a mingled Salt, all proceeding from a Mixture of Alcaline Salts, as $P_{0 t}-A \beta$, or Volatile Salts with an Acid.

Sect. IV. Experiments, fewing that Acids and Alcalies precipitate, or are feparated from each other.

Besides this, when fome of the faid Alcalies and Acid's already united with each other, and, as they term it, are fo far fatiated, that they will not act any longer upon others of the fame Kind, and adhere fo clofely to the former, that it would be very troublefome to ieparate them again without the Addition of other Matter, and in fome Cafes even impoffible

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poffible to do it at all; Tryals of the Operations of thefe Salts upon one another have taught Inquirers, that there are likewife among thofe Laws obferved by the Acid and Alcaline Salts, fome whereby this ftrict and clofe Union may be very eafily, and yet as it were miraculoufly diffolved, and each of them feparated from the other in fuch a manner, as if one of them thruft t'other Way, or at lealt quitted its hold, without any external Caufe that we have as yet been able to difcover.

Thus we find, that one Acid feems ftronger than another, and that how ftrictly foever fome Acids are joined with Alcalies, one need do no more in many Cales than to put another Acid to it, whereby to oblige the firft Acid to forfake its Alcali, and then the fecond will unite itfelf to it. The fame thing does likewife obtain in Alcalies, fo that one of them fhall immediately feparate itfelf from its Acid, and leave the latter to be join'd thereto.

Many Inftances thereof may be met with in Chymiftry, but we fhall content ourfelves with quoting one of each.

Pour Spirit of Sea-Salt, which is an Acid, upon the Alcaline Salt of Tartar, they will effervefce, and unite themfelves into a third mix'd Salt, which is like the Sea-Salt : But how much Fire and Pains it will coft to feparate this Acid Spirit of Salt from the Alcaline Salt of Tartar, is well known to thofe that have made the Tryal ; but if you put a little Water to it, and fome of the Acid Spirit of Salt-Petre, the Acid of the Sea-Salt will quit its Alcali without any Trouble, and fuffer itfelf to be drawn off by a fmall Fire; whilft at the fame time the faid Spirit of Salt-Petre unites itfelf with the Alcali, or Salt of Tartar, and thereupon produces a new matter of Burning Salt-Petre, upon which if you pour again an Acid Spirit of Cop- Separation between the Acid Spirit of Salt-Petre and the faid Alcali; which may likewife be extracted from thence with a foft Fire from Sand; and this third Acid, or Spirit of Vitriol, will unite itfelf to the Salt of Tartar, from which there will refult another Salt, almof of the fame kind with that which is commonly called Tartarus Vitriolatus.

To fhew the fame likewife in the Operation of feveral Alcalies, pour the faid Spirit of Sea-Salt upon the Volatile Alcaline Salt of Animals, of Harthorn, of Sal Armoniac, and the like, diffolved in Water, whereupon, after an Effervefcence, they are united into a third, like Sal Armoniac, and the Volatile Salt will thereupon lofe a great part of its Volatility and Scent in the Mixture. Now if you add Salt of Tartar for a fecond Alcali, it will feparate the firft, and difcover itfelf prefently by a new ftrong Smell, and the fecond A1cali, or Salt of Tartar, will unite itfelf with the Acid of Sea-Salt. They that have a mind to fee feveral Kinds of Alcalies, the firt of which, by the Addition of a fecond, will feparate itfelf from the Acid, may be pleafed to confult the following Contemplation, Sect. VI. befides innumerable Inftances wherewith Chymiftry can furnifh 'em ; but we fhall not, nor cannot bere determine any thing about the Manner ufed herein by the wonderful Power of God, reckoning it fufficient that the thing is plain enough in itfelf.

S ec t. V. Acid Salts difperfed in many Bodies.
It mult not be thought, that thefe Effervefcenccs, and Actions of Acids and Alcalies, have only place in Chymical Liquors; and that we therefore go too far in honouring them with the great Name of a Law of Nature; forafmuch as they,
that is, one or other of them, are found in many Terreftrial Bodies, and that a great deal of that Matrer of which many Bodies are compofed, may be reduced to Acids or Alcalies.

To flew this in the Acid:
In Animals all the Milk and Serum, or Whey, is Acid; not to enumerate any other Juices here, particularly thofe Acid Humours which oftentimes occur in many unhealthy Creatures; or, as fome maintain, are always found in the Stomach of healthy ones.

We likewife meet with Acids in Minerals, as in Sulphur, Copperas, Allum, Salt-Petre, Sea and Rock-Salt, in Antimony and others.

In Plants we likewile find fome that yield an Acid Spirit by Diftillation; befides all thofe Fruits which are foure becaufe they are not ripe, we meet with an infinite number, which after they are come to their full Ripenefs, do retain an entire Acid or fourifh Tafte; fuch as Currants, Oranges and Limons, many Apples and Pears, and the like. Befides that almoft all Liquors proceeding from Plants, or other things, by way of Fermentation, fuch as Beers, Wines, and the like, will turn to an Acid or Vinegar.

The Air itfelf feems to be impregnated with foure Particles, fince it will corrode and caufe Iron to ruft.

There are likewife Medicinal Springs that yield fourifh Waters, found in many Countries; fee Varenius's Geography, Part. abs Cap. 17. Sect. 6. of which he makes the number in Germany alone to amount to about 1000 ; fo that from hence may be inferred the Quantity of Acids difperfed throughout the whole Earth.

Secr.'

S ect. VI. Alcaline Salts likewife difperfed in many Bodies.

One may fay the fame thing of the Alcaline Salts alfo.

From all the Parts in a manner of Animals, there are Alcaline Volatile Salts extracted in great Quantities; to fay nothing here of other Alcalies, which cannot properly be named Salts, fuch as Crabs-Eyes, Egg-Shells, the burnt Shells of Oyfters and Mufcles, Harthorn and Bones.

Plants, when putrify'd or rotten, do likewife yield Alcaline Volatile Salts. The Smoak of burnt Wood makes a Soot, which does alfo afford an Alcaline Volatile Salt; and the Leaves of fome Plants, fuch as the Palm, yield an Alcaline Spirit by Diftillation. The Chymifts do moreover extract from moft Plants by Burning, a fix'd and lixiviate Salt, which is likewife Alcaline, and of which the Afhes themfelves will effervefce with Acids.

All fort of Coral is Alcaline, fo are many Minerals, and will ferment with Acids; as alfo all Metals, Gold, Silver, Copper, Iron, Tin, Lead, Quickfilver, Antimony, Marcafites, the Lapis Calaminaris, Chalk, ©rc. Even a good fertile Earth will effervefce with Spirit of Salt-Petre. There are likewife fome of the Mountain or Rock-Salts of the fame Nature. Accordingly we are informed, that in the Repofitory of the Royal Society of England, there is preferved a Salt brought from the Rocky Places of the Ifland of Teneriff, the Properties of which are entirely Alcaline ; and in how many Mineral Waters a like Alcaline Salt is found, may be feen in the Hiftory of the Academie Royale des Sciences, \&ix. An. 1702, p. 57 and 58 , and 1708, p. 73 and

74 ; where an Inquiry being made into the Waters of Bourbon, Lancy, Bourbon d'Archambaut, Bourboule, Mont d'Or, Chaudes, Aigues, Evaux, Neris and Vtchil, are all found to yield a natural Alcaline Salt: So that it likewife appears from hence, that Alcalies as well as Acids may be met with in great Quantities in many Bodies.

Sect. VII. Convitions from the foregoing Obfervations.

From what has been faid, and from a farther Inquiry into Nature, one might produce a vaft number of Experiments and Proofs, capable of convincing a judicious Reader, that there is an infinite number of Particles in the World, each of which are conftantly moved according to particular Laws, which in fome Circumftances are at reft, and of which others being brought to a certain determinate diftance, as the Acids and Alcalies, begin a regular Motion, being fometimes attraited, and at other times repelled from each other. Do not the Parts of Diamonds adhere together very clofely, tho' they have great Orifes or Pores in them, and therefore touch one another with little Superficies, as appears from their Tranfparency? Do not we fee in Fermentations fome Particles which were at firft ftill and at reft, and afterwards begin to move among one another, in which, atways following certain Laws, they one while feparate, and then again unite with each other? But they who defire to fee a brief Collection thereof at one view, may confult Sir Ifaac Newton's Optics, in the Queries at the End, and moft of the Chymifts; and from thence extract what they think may ferve for a Proof ftrong enough of what has been faid above.

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But to fuch as are not fo well experienced in Chymiftry, to give a more familiar Inftance from whence they may fafely infer the foregoing Propofitions, and juftly conclude likewife that there is a God, who has not only Created all thefe things, but does alfo Govern them by his Providence according to wife Laws; let an Atheift, how great a Philofopher foever he be, reflect with himfelf, and confider, Firyt, this Univerfe, as confifting of an infinite Multitude of Hundreds of Thoufands of Millions of Particles, which, according to the preceding Experiments, cannot be deny'd; Secondly, let him reprefent to himfelf all thefe Particles as being at reft and unmoved; which he may eafily do, becaufe Motion is not a neceffary Confequence of their Exiftence : If now he contemplates this unconceivably great Heap of Matter, can he think it credible, firft, That from thence are produced fo many determinate, and fuch exceeding fmall Stamina, or Original Seeds, and from them again fo many glorious Machines, as are the Bodies of Men and Beafts, Fifhes and Birds? Such wonderful Structures of Plants and Herbs, divifible into fuch numerous Claffes? So many agreeable Liquors which Men extract from the fame, making ufe therein of thofe Laws, according to which the Juice of the Grape, for Inltance, and others are wont fo uniformly and conftantly to operate? Finally, that great and amazing Machine the World itfelf, with that Order and Symetry, by which one part thereof renders fo many Services to the other, whilft not one fingle Particle thereof can affume any kind of Figure or Motion, but according to certain Laws prefcribed to it, by and fubfervient to the great Defigns of its Creator; nor can it feparate itfelf from one, nor adhere to another Body, but in Subordination to the fame Laws.

Sect.

## S ect . VIII. The Prefervation of Things proves a God.

We muft not think that nothing but thefe Laws, and the infinite Wifdom by which they have been contrived, has place in the great and regular Structure of the World ; for the preferving and continuing of all things in the State and Condition in which they were firft created, has likewife a Share in proving a God.

Would we fee a Proof thereof, how the great Director, from a Collection of an inexpreffible number of Particles entirely differing from each other, and which feems to us to be jumbled together in the utmof Confufion, caufes only fome determinate ones, and fuch as are fubfervient to his high Defigns, to approach towards each other, and to unite among themfelves and with other Bodies proper to preferve, nourifh and increafe them according to the Laws impreffed therein by his infinite Providence; let us recollect what has been faid above upon this Occafion.

Is not the Air a Mixture, yea, a very Chaos, confifting of Hundreds of Thoufands of Millions of different Particles? How many things confumed by Fire, and diffolved by Corruption, do mingle their Effluvia, Steems, or Vapours, with the Air ? How many Men and Beafts do perfpire therein; yea, according to Mr. Boyle, almoft all Bodies, not excepting Ice and Snow themfelves, become lighter by Perfpiration, and tranfmit their exhaled Particles into the Air ? How many fweetfcented Flowers, how many Spices and other things impregnate the fame with fragrant Particles, infomuch that the Perfumes of them have been fmelt fome Leagues difance from the Illands where they grow, according to the Relations of thofe who have experienced the fame? Every body

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body knows, that in Cellars where there are fermenting Wines, the Air is full of their Vapours and Spirits; which holds true likewife in all other fermenting Matters. How many watryVapours from Seas, Rivers, Lakes, Marfhes; how many fulphureous and other corrofive and poifonous Particles afcending from burning Mountains, mingle themfelves with the Air? Iron which, in all Parts of the World almoft, being expofed to the naked Air, becomes rulty, furnifhes us with unqueftionable Proofs of the Acidity thereof. With all thefe there is mingled an unconceivable quantity of Rays of Light, derived from the Sun and other Heavenly Bodies; and how much Fire is elevated and retained there, appears by Lightning and other ignite Meteors. Add to all this the proper Particles of which the Air itfelf is compofed, and let an Atheift tell us, where he can find fuch another confufed Heap.

Let him farther confider the Earth, and obferve of what a mighty Variety of Kinds and Parts it confifts. Water is turned to Earth, as we have fhewn before; poifonous and wholfome Herbs, Shrubs and Trees, all the Bodies of Fifhes, Beafts, and Men do likewife become Earth. In a word, whatever proceeds from the Earth, is by Corruption or otherwife changed into the fame. Let an Atheift reflect again, how many Thoufands of Kinds of different Compofitions all this Heap of Matter might produce, every one of which might likewife be exceedingly different from all that we now fee proceeding from the Earth.

In the Water we may obferve the fame; How many Plants and Fifhes are corrupted therein? What a great diverfity of Dews fall upon it, drawing Particles of the Air along with them? How many Salts are diffolved therein? How many fubterraneous Fires fill them with the Matter that burfts
burts out of their Caverns? Water wathes all Filthinefs off, and how many Particles does it borrow from the Things in and upon which it has ftood any while? Coffee and Tea, all fort of brewed Liquors, the Off-fcourings of Apothecaries Shops and Kitchens; to fay nothing of Minerals, of hot, bitter, and poifonous Liquors, nor yet of falt Sea-Waters; all thefe things, 1 fay, furnifh us with Proofs that are obvious to every one.

To take no notice neither of Fire, which does in a manner unite all things with itfelf; let the Atheift reprefent to himfelf all thefe confufed Collections of Water, Earth and Air; and in cafe there were no Laws by which each kind were particularly governed, and purfuant to which thefe Particles join themfelves with fome Bodies, and again refufe to come near others, could he himfelf, or any body elfe think it poffible, that from all this Chaos, there fhould not once, but eren frequently, and from fome of them every Year, be produced anew fo many different things of particular Properties, and that it would have fo happened as long as the World has lafted ?

To give an Inftance in one kind of thing only.' Let any body fow different forts of Seeds by one another in the fame Earth; they will ftand in the fame Air, they will be moiftened with the fame Water, warmed with the fame San, and acquire from them all, according to what has been Thewn above, an infinite number of different Particles round about them. Now let fuch, who to their own Misfortune deny a Divine Providence, tell us how this can poffibly happen, were it not that certain Laws obtained in all thefe numerous kinds of Parts, and which are the Caufe that every Particle neceflary to the Growth of every individual Seed, does unite itfelf therewith, and to no
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other of different Properties, and how every Seed can always produce its own Plant of the fame Kind and Virtue every Year without once failing? And why, when there are fuch poifonousHerbs as Aconitum, Hemlock, and the like, fcattered and mingled in the fame Earth with Wheat, Rye, Barley, and other Grain fo ufeful to Mankind, there are joined only to the firf, fatal and deadly Particles, and to the latter, only wholfome ones? And why an Apple-Tree never bears Pears, or a Vine, Cherries?
$S_{\mathrm{E}}$ т.IX. All kinds of Pbilofophy do, or muff, acknowledge Laws.

Let the moft experienc'd Philofophers be called upon, and let them tell us themfelves, if they will declare their Sentiments impartially, whether, without acknowledging thefe Laws and a directing Providence, they can make thefe and fuch like Phoenomena (for there are many fuch in the World) the neceflary Confequences of the Hypothefes upon which they found the Science of Nature.

Some have thought upon a Magnetical, and other kind of Attractions; but thefe lay down one fort of Laws.

Others fuppofe a certain kind of Ferment, as the Chymifts fite it, in the Stamina, or Principles of Seeds, of which there can be no other Notion formed, than that they are Parts figured after a particular Manner, and moved according to certain particular Laws, and which unite themfelves with fome Bodies, and feparate from others.

Finally, fince both thefe Hypothefes have been rejected of later Years, thofe that have philofophized more rationally, have laid down, that there ate Pores or Orifices in Seeds of certain Figures, through which only are admitted Particles of the
like Figure ; which, according to the Opinion of others, who will not own a Direction, becaufe that leads them to a God, may come to pafs by Chance or Neceffity, fince there feems to be nothing more requifite thereto, than that thefe Pores fhould be difpofed to receive thofe little Particles as foon as they are put into Motion. But according to this Hypothefis there might, firft, not only all kind of Particles be admitted into the Pores of the Seed, provided they were but fmall enough; but likewife, fecondly, there would hardly be one Seed capable of growing, and but very few Particles enter into the fame, fave only round ones, if nothing but meer Chance obtained therein, as Dr. Pitcairn has exprefly and mathemarically demonftrated in his Differtations; fince the fame kind of Particles muft always prefent themfelves before the fame Pores, and exactly after the fame manner, if they would gain Admittance. But let us fhew this by a more familiar Inftance: Suppofe any one fhould undertake to throw a Die through a fquare Hole, through which it could but juft pafs; mult he not ftipulate, in order to have an equal Chance of winning or lofing, to repeat his Throw a great many times? So that if fomething like this fould be the true Caufe of growing of Plants, and all the Particles of the Figure of a Die fhould always pafs through the fquare Pores in a Seed; there muft at leaft in this Cafe, as much as in any other, be a Rule or Law, according to which each Die muft be difpofed when it comes againft the Orifice or Hole.

We do not here difpute, whether any thing of all this, or fomewhat elfe, be the real Canfe, that among fo many Thoulands of various Particles, thofe only approach to, or are attracted by each Seed, which are moft proper to compofe the par. ticular Plant in its kind; but our Difign was only
to fhew, that without acknowledging a Divine Direction, whereby all things are moved according to the requifite Laws, whereby fome things are made to approach, and others to recede, and which are extended to every one of thefe unconceivably fmall Atoms, no other Hypothefis has hitherto been offer'd, whereby the Growth of Plants and many other Things could have been refolved. In fhort, to obviate all the Evafions of Atheifts, let us recollect from what has been faid above, that among the Thoufands of kinds of Animals and Plants, there is not one only to be found which was not at firft formed of an exceeding fmall Stamen, containing all the Parts thereof in Miniature, and from whence, by Expanfion or Unfolding, and by covering or cloathing with adventitious, particular and determinate Matter, all Plants, all Men, Beafts, Fifhes, Fowls, and every other living Creature are produced, as is well known by the general Experience of thofe that ufe Microfcopes. Let then the Atheift or Sceptic think with himfelf, whether he can reconcile all this to a mere and accidental Concourfe of ignorant things; and thefe curious little Forms and Figures, in which all that is neceffary to fo many wonderful Purpofes in great Bodies, are compris'd in a much fmaller Quantity than a Grain of Sand: I fay, let him make all thefe things agree with thofe neceffary Laws, that operate without any wife Direction or View. After fo many illuftrious experimental Proofs of the Wifdom of an adorable Creator, no reafonable Perfon can require any more ; efpecially if it be true (as fome Great Men think it very probable) that in all thefe Stamens, how fmall foever they may be, thofe of all others that are to be produced to the end of Ages, are actually to be found in their determinate Figures. Fertility.

I Don't know, whether it may not be thought proper by fome to add to all this, one Notion more, which appears very plaufible to many, but yet feems to require a farther Examination and Trial before it be entirely admitted for certain : But fince the fame has been entertained by feveral Great Men, and feems to have fome Analogy with the Chymical Operations and Adtion of the Parts of Matter upon one another, and efpecially fince the thing carries along with it a great Proof of God's Providence; it may perhaps be of ufe, if we here fubjoin a few Obfervations that may fet the fame in fome kind of light; and, it may be, alfo excite thereby fome of the Learned to look farther into a thing that is at leaft worth double their Pains.

It confifts in the Inquiry of what may properly be the Means which the Gracious Preferver of all things makes ufe of to render the Earth fertile, and to caufe Plants to grow powerfully therein.

Now that which may be experimentally pronounced upon this matter, according to the Opinions of many Naturalifts, is, that the Nitre of the Air is the Caufe thereof; to which perhaps one may add, that fince Nitre, or Salt-Petre, is alone and of itfelf an unactive Matter, there muft fomething elfe concur to put it into Motion ; much after the fame manner as ir happens to the Acids and Alcalies, which, when feparate, are at reft, but being put together will effervefce and boil up with each other. The fame happens by the Mixture of Sait-Petre and Brimfone in Gunpowder.

Sect. XI. The Air Seems to abound with Salt-Petre; feven Experiments Jhewing the Probability thereof.
Now to prove, if not with entire Certainty, yet with great appearance of Truth, that either Salt-Petre is in the Air, or at leaft fome other Matter, which being much of the fame Nature, meets fometimes with fomething elfe in the Earth, whereby between them real Salt-Petre is produced, appears from the foilowing Experiments.
I. That the Earth may be mixed with fuch Matters upon which the Air will operate ; fuch as the Filings of Iron, the Urine, Dung and Blood of Animals, lixiviated Chalk and Afles, $\mathcal{C} c$. and that from fuch Mixtures, after they have been expofed for feveral Months to the action of the naked Air, a remarkable quantity of Salt-Petre may be extracted.

But forafmuch as great and learned Men feem to differ about this Aërial Salt-Petre, I thought fit, for greater certainty, to make this Experiment, and found by the Event, that fuch an Earth after being managed properly, yielded in a Months time about three Pound of very good raw SaltPetre. This has been touched upon before, fo that what is here faid, may be the more fafely depended on, and the rather, if we add what feveral have affirmed to be experimentally true, namely, that the Earth from which Salt-Petre has been once extracted, will after a while be again impregnated by the Air with the fame.
II. Since every Body may find, that by letting Blood run out of a Vein upon Water in which Salt-Petre is diffolved, the black or dark Colour thereof,
thereof, will be immediately turned into a bright Red; and the Serum or Whey of the Blood become as tranfparent as clear Water, tho' it retains its Nutritious, or at leaft folid Parts ; which by dropping a little Spirit of Salt-Petre upon it, may likewife be feparated therefrom; yea it is known that black Venous Blood being expofed in a Veffel or Porringer, is often red at the Place where the Air touches it; and that even upon taking off the upper red Part, the Black which was under will likewife affume a bright red Co lour : I fhall not here difpute, whether the Air is mingled with the Blood in the Lungs, becaufe this is doubted by fome Philofophers; but however it is plain from thefe two Tryals, that SaltPetre and Air do act uniformly upon the Blood; and therefore it is in fome manner probable, that the Air is impregnated with Salt-Petre.
III. It is known to the Naturalifs, that a great deal of Salt-Petre may be made from Blood (See de Stair de Nitro) if now it be true, that in Breathing, the Air is continually mingled with our Blood, one would be apt to imagine, that it leaves a great deal of its nitrous Quality therein, which may afterwards be extracted.
IV. Since refined Salt-Petre being held in a warm Hand, will fnap and break, which perhaps might be occafioned by the Air that was in it ; I took a Piece of Salt-Petre and threw it into a bright Lie, in which there is never any Air ; then putting it into the Air-Pump, I obferved a great Stream of Air-Bubbles coming out of the Salt-Petre, and afcending thro' the Lie.

Now whether from this Experiment it may be concluded, that the Parts of Air and Salt-Petre are eafily united and adhere clofe together, be-

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V. This feems however to be entirely removed thereby ; forafmuch as the Obfervations made by the new Burning-Glaffes fhew, that Salt-Petre held in their Focus, entirely evaporates, and fo mingles itfelf with the Air Hif. de l'Acad. \&c. 1699, p. 114.
VI. All Metals, fuch as Silver, Iron, Copper, Lead, which are diffolved by the Spirit of SaltPetre, efpecially thofe upon which it acts with the greateft Force, as it does upon Iron, feem to ruft in the Air; only Gold, which a fimple Spirit of Salt-Petre can't touch, is not fo much expofed thereto: All which gives a handle to a Conjecture, that if there be not Salt-Petre itfelf, there is at leaft fome Matter of the like Nature in the Air.
VII. A yet farther Proof that there is fomething Nitrous in the Air, feems to refult from the pains in the Head, faintnefs and difpofitions to Vomit, which often appear in fome Women when they are in clofe Rcoms, where a great many People and Stoves are. To be fatisfy'd of this Confequence, the Reader may be pleafed to recollect what we have fhewn above in the VIIth Contemplation, namely, that Flame and human Refpiration are maintain'd by the fame kind of Air-Particles; for which reafon, the Air thut up in a Room where a great many Stoves are burn-
ing, and a great many People breathing, mult be very much divefted of thofe Parts, and be the occafion that fome weak Women are diforder'd thereby. Now that thefe Parts are properly Nitre or Salt-Petre, which being render'd by the warmth of the Fire and Breathing, unfit to difcharge its Functions, feems to appear from hence, that Women thus diforder'd, cannot recover themfelves by any better Means that I know of, efpecially when the frefh Air won't do, than by the ufe of a NitrousSalt diffolved in Water, of which I have feen many Experiments, either by putting a little Salt-Petre or Sal Prunelle in their Mouths, and letting it diffolve gently, and fwallow it down.

Sect. XII. Salt-Petre feems to come out of the North; proved by three Experiments.

Since now the firf of the Experiments feems to prove, and the other to make it very probable, that the Air has either Salt-Petre in it, or fomething of a nitrous Quality; it will appear in fome manner from the following Experiments, that the fame, at leaft on our fide of the Equinoctial Line, proceedschiefly from the North.
I. Not to mention that the Air is cold to a great Degree in the Northern Parts of the World, (as for the South Pole, we take no notice of it now) nor that Salt-Petre does after a particular manner produce fenfible Coldnefs, as we fee by putting of Bottles of Wine in Summer-time in Water, and throwing a good quantity of SaltPetre into it, which chills it fo much, that fome have thought that one might freeze Water thereby, but that 1 fhall not determine : From hence it may be confider'd, whether that Air which makes

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makes fo many Mountains of Ice in the frigid Zone, and keeps them always undifiolved, muft not greatly abound with Salt-Petre.
II. To render this the more probable, we fhall add what the Learned Hambergerus relates from the Ephem. Barom. of Mr. Bernard Ramazzini; that Gentleman fays, that the Excrefcence of Salt-Petre from old Walls made of Mortar and Stone, does moftly appear in Winter, and when the Northerly Winds blow; and that thofe who make it their Bufinefs to gather Salt-Petre, do at that time particularly fweep the Walls; and that they get more of that Matter from Walls that ftand to the North than to the South; which feems to prove plainly enough, that befides the general Impregnation of the Air with Salt-Petre, the Northern Air does moftly abound therewith, and that it is frequently brought from thofe Parts to us.
III. Now whether it may be inferr'd, that upon account of nitrous Salt, the Northerly Winds make the Air heavier, and that upon the turning of the Wind to that Corner, the Mercury does often rife in the Barometer, as many who have writ upon this Matter affirm, I fhall not here inquire after.

Now whether the Air be render'd heavier by the Northerly Winds (which bring along with them from the cold Regions, a thick and compos'd Air towards the South, as appears from rhe Thermometers, in which we may obferve, that Cold compreffes the Air, and as appears likewife by the Refraction of Light, which is affirmed to be greater in the Nortb) or whether fuch Gravity of the Air proceeds from the Salt-Petre wherewith it is impregnated, or for other Reafons: They who ufe Barometers know very well, that the heavier
heavier the Air is, and the higher the Quick-Silver rifes, the lefs rainy and the more dry Weather may be expected. See the AEZ. Lipf. 1696. p. 213. from whence therefore, befides other Circumftances that may be peculiar to the Country of the Fewr, the Reafon in general may be affigned of that Expreffion in Solomon's Proverbs, Chap. xxv. ver. 23. The North Wind driveth away Rain, fince by the greater Weight of the Air, the watry Vapours remain floating therein, and cannot defcend in Rain.

Sect. XIII. Salt-Petre becomes aitive by thofe Particles in it that are Sulphareous, Joewn by Experiments.

But fince Salt-Perre feems to be very unactive in its own Nature, infomuch as when put into a Melting-pot over the Fire, it does not exert the leaft active Faculty, even with great Heat ; it may be neceffary to examine a littje more clofely, what it is that renders it Active (as Acids and Alcalies working upon each other) and how it comes to produce fich Wonders.

Now the Bodies which are more peculiarly properto produce fuch an Effect are all fuch as come under the Denomination of Sulphur among the Chymifts ; to which belongs common Sulphur itfelf in the firft Piace, and every Thing elfe that has Sulphur in it; fuch as Antimony, Turf, and WoodCoal; and in general, all that has Fat or Oyl in it, fuch as Tartar and the like.

Thus we fee that Sulphur or fulphureous Bodies, thrown into melted and glowing Salt-Petre, or elfe being mingled cold with the fame, and fet on Fire, are put into violent Motions, and the Mixture often turned into a fudden and confuming Flame: So likewife we find that Tartar mingled
mingled with a like quantity of Salt-Petre, will be kindled with the fmalleft Fire, and burn fo long, till the Oleaginous and other parts of the Tartar are evaporated; after which there will remain a white Alcaline Salt, which is therefore cailed Salt of Tartar. After the fame manner we fee diffolved Salt-Petre mixed with beaten Charcoal, or Turf char'd and thrown into the Fire, become active, and caft out Flames; where being continued till no more Flame is perceived, the Chymifts make of it an Alcaline Salt, which they call the fixt Salt of Nitre: But whether it may not more juftly be termed the fixt Salt of Coals, for the fame Reafon as t'other is called the Salt of Tartar, I leave to the Learned: At leaft, how very active Salt-Petre is render'd by Su'phur and Coals, Gunpowder furnifhes us with a wellknown, or rather with a wonderful and terrible Intance.

It muft not be thought that thefe Matters cannot be kept up in the Air, as not being fine and fmall enough, becaufe we have fhewn before, that befides a great many other different Particles, there are likewife thofe of Sulphur found in the Air. Thus we fee, that in the Mediterranean, and other Parts of theWorld that are more Southern than we, there is very great and frequent Thunder and Lightning, of which in Greenland (as I have been informed by one that has been often there) and here with us in Winter, very little is obferved. Now that this is occafion'd becaufe the Air abounds with more Sulphur in the former Regions than in the latter, (whereas in Greenland there feems to be more of Salt-Petre only, which paffing from the Northern to the Southern Parts, produces there Effeets in Conjunction with the fulphureous Air) is allowed by many as a very probable Thing,

It has been likewife fhewn above, that the Rays of the Sun operate upon Salt-Petre, and render the fame Volatile; for, that thofe Rays are Corporeal, and do likewife even bring along with them a Matter that gravitates, appears from the Experiment of Mr. Homberg about the Regulus, of Ifing-Glafs, as the Chymifts callit. See the XXIVth Contemplation.

I know not whether I may not here add, that in the Year 1711, having gathered fome Dew about the latter end of May, and kept it a while in a great Glafs Veffel, I caus'd the fame to evaporate, in order to try whether there were not Salt-Petre in it, as fome affirm; but found no Salt at that time, but only a little reddifh Matter pretty near the Colour of the Scoria, of Regulus Antimonii; which being fprinkled upon a glowing Coal, would not burn as Salt-Petre is wont to do ; but when thrown into an earthen Veffel, in which there was glowing Salt-Petre, it flamed vifibly, but however pretty faintly in comparifon of common Sulphur.

I cannot here determine exactly of what Na ture that Matter was, there being too little of it to bear a further Examination; but however, I judgeit to be of a fulphureous Nature, by its flafhing with melted Salt-Petre; at leaft it was plain enough that Salt-Petre acted upon this, and this upon Salt-Petre.

It likewife feemed as if we might conclude from thence, the Operation of the Solar Matter brought to us by the South-Winds upon the Aërial Salt Petre, fince we find that a glowing Coal of Turf being placed in a hot Sun-fhine (out of the Wind which would otherwife blow it up) is extinguifhed, and ceafes to burn, juft as if it were put into a Quenching Pot. The Reafon of which feems to be, that the Salt-Petre of the

Air, which is otherwife the principal caufe of our Turfs burning, is render'd unfit by the Action of this Matter, which proceeds from the Sun, to continue the Fire of this Turf-Coal as well as before. Now that this is true, and that Salt-Petre is a great caufe of the burning of our Fires, appears from hence; becaufe, that in the frong Frofts of Winter, when the fharp Northerly Winds reign, which have been proved before to be impregnated with a great deal of Salt-Petre, our Turf-Fire burns much brighter, and is much fooner confumed (as Coals are upon which one throws Salt Petre) than in Summer, when the Air has not fo much pure Salt-Petre in it.

Sect. XIV. Salt-Petre in Conjunction with the Rays of the Sun, does likewife render the Earth fruitful, Joewn by an Experiment.

Thus we find alfo, that the Action of SaltPetre, and the Rays of the Sun, do contribute very much to Fertility. Not to relate here, for a Proof, Mr. Homberg's Experiment in the Trainfattions of the French Academy 1699, p. 75, 76, which fhews the fame of Salt-Petre when diluted in Water, and poured upon Earth: One may likewife make another tryal, by fteeping Grain or Seeds for fome Hours in two Pints and half, for Infance, of Water, in which an Ounce of the beft Pipe Salt-Petre has been diffolved, and fo proportionably ; and it will be found that thefe Seeds will be much more fruitful than any other that have not thus been infufed in Water unpregnated with Salt-Petre. I faw the Experiment thereof in the Year 1711, when fome French-Beans that had been fteep'd were obferv'd to grow a third Part higher than others; and have treated fome Purlain-Seeds in the fame manncr, that it grew
fo large, and fo frong, that a Learned Gentleman, and one that was well verfed in Plants, could not forbear asking what it was, and faid, he had never feen fuch Purnain in his Life.

This Property of Salt-Petre was likewife known. to thofe of the Ancients that have writ upon Agriculture: But to thew farther that which was propoled, namely, that not only Salt-Petre, but that which likewife proceeds from the Operation of the Solar Matter thereupon (allow me fo to name either the Sun-Beams themfelves, or that which they bring along with them) does render the Earth fruitful : It will be fufficient in the firft Place, to confider how much the Sun contributes to the growth of Plants, this being unknown to no Body; and it will give fome Light to the Matter to mention here, that which happen'd to me about the latter end of May, in the Year 1712 ; for having fown Purflain, fome of which had been fteep'd in Salt-Petre Water, and other not, at the fame Time and Place; fome Days after which the Nights were fo cold as to make Ice; and I having found by former Experiments, that in the ftrongeft Frofts there would be found no Ice in Lye, and little or none in common Pickles; that a Water in which there was as much SaltPetre diffolved as could be, being fet within-fide, or even without-fide of the Window, in a little Bottle clofe to the others in which the Seeds were, that Water was fo ftrongly frozen as to crack the Glafs, the Parts of which were feparated more than the breadth of a Straw ; it came into my Head, whether fince the Salt-Petre Water froze fo eafily and fo hard, the Purlain, the Seed of which had been fteep'd in the like Water, might not be killed by this Froft, efpecially fince the Sun had hardly appeared during all that time, which was very cold; and going to the Window to fee, I found
that that Seed which had been fowed after the common manner, was green, and that, that had lain in the Salt-Petre Water, much more advanced in thofe Parts that remained alive; but that moft of it was frozen and dead.
From hence I think we may infer, that in order to make Plants grow and flourifh, not oniy Salt-Petre, but likewife fomething that proceeds from the Sun is requifite thereto; to the end, that by their reciprocal Action, they may concur in the producing thefe Effects upon the Earth, and the Plants thereof.

Befides, that this feems to be further confirmed by a common Experiment obferved by fome Husbandmen, namely, that when in the Month of March, and the beginning of April, North and North-eafterly Winds blow a long while together; and thereupon it is apprehended, that they fhall have a bad Year, and that the Grafs by reafon of the cold does not fpring up, there is oftentimes a very good Crop, and even an early Hay-Harvef ; for fome Years I obferved it, and found it always to be true, efpecially in the Year 1712, when by reafon of the frequent Northerly Winds in the Spring, fomebody faid to me, that he feared it would be a bad Seafon, and that Hay would be fcarce; to which I anfwer'd, that I had often found the contrary, and that if it were but followed with a good warm Sunfhine, the Grafs would perhaps be early ripe, and there would be a great quantity of Hay, which likewife happen'd

Now they who allow the Probability of what has been advanced, may eafily infer the Caufe from thence, namely, that the frequent Northerly Winds might bring great Quantities of Salt-Petre to us, which being fucceeded by the Southerly

Winds

Winds, and the Solar Matter that accompanies them, a great Quantity of thofe Particles which att upon each other, and contribute to Fercility, is then found in our Air; tho' on the other fide it may fo happen, that the Northerly Winds fhall be fo ftrong and lafting, and the Southerly fo weak, and the warm Weather fo little, that the Aerial Salt-Petre may be as prejudicial to the Fruits of the Earth, by reafon of its too grear Plenty, as the common Salt-Petre (the Experiment whereof is mentioned above) which being ufed in too great a Quantity, killed the Plants. With this agrees the common Proverb of the Husbandmen, confirmed by numerous Experiments, that a Peck of March Duft is worth a King's Ranfom. That Month being commonly dry with us when the North Winds blow, by which the Air is render'd fo heavy, that the watry Vapours will remain floating in them, and cannot defcend in Rain, which with Southerly Winds are wont to come plentifully down at the fame Seafon.

Sect. XV. Convictions from the foregoing Obfervations.

I Have dwelt the longer upon this Matter, not only becaufe the abovementioned Experiments require to be expreffed and propofed with fome Clearnefs in their Circumftances; but particularly in order to ftir up others that have Inclination and Conveniences, to inquire more narrowly what it is properly that renders Lands fruitful, and makes Plants grow more freely; to the end that they may erther corroborate what we have here faid, by farther Experiments; or otherwife, if they find that the Works of Nature exert themfelves after a different manner, they may communicate their Lights to the World; fince

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there ftill feems to be wanting numbers of Experiments : For Inftance, how to order fuch an Earth, or fuch Seeds, fo as that in a few Hours a Sallad, or other Piants fit for ufe, may be produced; or again, that each Seed may at the fame time put forth all the Seed Plants contained in it, and make them grow equally, by which means the Fruits ef the Earth might be multiplied; and fuch like Experiments. At lealt every one will readily agree, that this is a matter, the Inquiry into which may not only much more illuftrate our Knowledge of Nature, but likewife be very beneficial to Mankind.
In the mean while, fince nobody can be ignorant that the Air is the Magazine or Treafury, "from whence that which renders the Earth fruitful is communicated thereto, as the frequent plowing and turning up the Earth, and expofing it to the Air, has fhewn experimentally for many Ages; can it be thought that it comes to pafs without a wife Providence, that there has never been any Want in the Air, of fuch Particles as are fit for that purpofe? That the Waters of Rain, Dew, and Snow, falling down through the Air, are impregnated therewith, in order to carry fuch Particles along with them, and to infinuate them deep enough into the Earth, fo as to fertilize the fame, and to difpofe it to furnifh all living Creatures with Food and Refrefhment?

CONTEM.

## CONTEMPLATION XXVIII.

Of the Poffibility of the RES URRECTION.

S Ect. I. The Objettion of the Saducees anfwer'd. by our Saviour, Matt. xxij. च. 29.

ISHO ul d here have made an end of contemplating the Laws of Nature, becaufe an Inquiry into all thofe, to which the Study of Nature, and particularly Chymiffry, leads us, would take up too much of out time here: But fince it may feem to contribute very much towards the illuftrating a Matter which is of great Importance, I fhall attempt to fet that matter likewife in fome Light, tho it is feldom handled upon Natural Principles, To enter therefore upon it:

It is well known, that among thofe unhappy Perfons who deny the $G$ od that made them, there be many who are wont not only frequently to ridicule the Confeffion of Chriftians about a Refurrection, but likewife to oppofe the fame after all imaginable Ways; and that others, who feem to treat this matter with more Reafon and Decency, are likewife accuftomed to form fome Objettions againft it, by which they think they do fufficiently prove the Impoffibility of a Refura reEtion.

I know very well, that in order to cut off all Difficulties and Cavillings raifed againft this Article of our Creed, by thofe who acknowledge a God, and believe the Holy Scriptures, nothing can be more ftrongly returned, than what our Lord

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was pleafed to anfwer to the Saducees who deny'd a Refurrection : re do err, not knowing the Scriptures, $^{\text {n }}$ nor the Power of God, Matt. xxij. v. 29. That is to fay, the Word which you admit to be Divine, fays fo; and no body ought to doubt, whether the Power of God be great enough to perform what he has faid.

SECT. II. It is not a greater Miracle to Raife a Body, than to Create it.

Bur fince we have here to do with a fort of deplorable Difputers, who have no Reverence either for God or the Scriptures, and who think that they are able to prove from their Philofophy, the Improbability, if not the Impoffibility thereof; I have been of Opinion, that altho' the Certainty of a future Refurrection can only be deduced from the Word of that God who never deceives any one, and that the Manner of it muft likewife be referred to his Wonder-working Power ; yet that it might be perhaps ufeful to fome, to fhew here, that all the Objections which they can raife againft it, are far from having any Strength in them: But on the contrary, that the few as yet known Laws of Nature and Appearances are more than fufficient to anfwer them all, at leaft all that have ever occurred to me, and to put the Poffibility of the Refurrection, the Proof of which is our prefent View oniy; quite out of doubt.

To begin therefore: Let one that denies or deubts of the Refurrection, tell us whether he is not forced to allow, that all the Food of which his Body confifts, as well as the Bodies of all his Progenitors, does proceed from the Earth, or rather is nothing more than a metamorphofed, or transformed Earth: (If he denies this, let him read what we have faid thereupon in the firft and fol-
ing Contemplations.) 'Tis a plain Confequence then, that his Body likewife proceeds from Earth.

And this being fo, it is no more ftrange that his Body which was once Earth, fhould be raifed again from the fame, than that it had acquired or received its firf Figure from thence. What Impoffibility is there, that fo wonderful and dreadful a Power, which made ufe of the Earth to form a humane Body before there was any fuch Being in the World, without its Knowledge, without its Concurrence, and after fuch a manner as is unconceivable to him and all other Created Beings, fhould now again think fit to make ufe of the fame Earth to the fame purpofe, and raife him up again from the Dead? Let this Philofopher fuppofe with us, that a Man were born and brought up in a Place where he fhould be entirely ignorant of the Nature of his Food: If now another Perfon came and fhewed him a Lump of Earth, out of which Rye and Wheat, or what elfe he might have ufed for Food, were produced; and if he told him, that his Body did not only proceed from, but was likewife maintained by this Earth; would not this Denier of the Refurrection think, as we do, that fuch a Man would make as many Scruples in admitting the fame for Truth, as others now do when we tell them, that their Body fhall once again proceed out of that Earth into which it is turned after Death? And would nat likewife even the moft Learned Inquirer of what happens in the World, be as much amazed at the Manner after which his Body is formed out of, and fupported by Earth? were it not that the Cuftom of feeing frequently how a human Creature is born and nourifhed, but never how he rifes from the Dead, would feem to make this matter more intelligible to him ; and, as it happens with $\mathrm{RrF}_{3}$ cuftomary

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Sect. III. Even the common Formation of Bodies is. Lefs credible than the Refurrection.

Let one that denies the Refurrection tell us, whether the Parts of which his vifible Body is compofed (for as for the exceeding fmall Stamina, we fhall takeno notice of them here) were not as much fcattered over the whole Earth about 5000 Years ago, as they, will be many Years after his Death, or at the End of the World ? (See concerning this matter more largely in the following Contemplation, Sect. V.) And whether it be more impoffible in this laft Cafe, than in the firt, to collect the Parts fo difperfed, and to bring them into order.

Again, if he were ignorant of the Manner by which the Production of Animals is performed, and had had no Opportunities of feeing the fame; let him ask himfelf whether he fiould admit it as a Truth, that a human Creature, for Inftance, lying for many Months in a Liquid Matter, like a Fifh in the Water, could be able to live ; whereas now the fame Creature, if kept but a few Minutes under Water, would perifh? And would not he think, that from bence he might alledge many Realons, why 'tis more probable that a Man fhould be produced, like a Plant, out of a Seed, or at leaft after fome other manner that does not lo directly contradic Experience? And yet he fees this comes to pals conftantly, and always after the fame manner, without any Variation. Can now the Refurrection of the Dead appear to him more wonderful, or even fo much? Since in this laft Gafe it is only required, that a Bady fhould be produced from the fame united

Parts; and the Manner after which a Man is now formed does befides this feem likewife to rưn counter to feveral plain Experiments, by which it appears neceflary that we fhould breathe in order to live; whereas we have neverthelefs fufficient Caufe to affirm, that a Child can live feveral Months in his Mother's Body without Refpiration.

This feems to be fufficiently proved, forafmuch as the Lungs of a Child that is ftill-born will fink in Water. Bergerus, p. 48 r. gives us an Experiment thereof, and tells us, that the Lungs of a Child born dead, being put into an Air-Pump, will not fwell, and when thrown into the Water will fubfide ; the quite contrary of which muft have happened, if the Child had been born alive, and had remained any time in the Air, fince fuch Air is never perfectly difcharged again from the Lungs, but there will always remain a fufficient Quantity thereof to caufe the fame to fwell, and to hinder the finking. Accordingly we find, that a piece of the Lungs of a Beaft newly killed, being emptied of Part of its Air by the Pump, will contract itfelf and fink deeper into the Water than before ; but however, it will not fubfide to the Bottom till, after much Pumping and a good deal of Trouble, the Air be quite exhaufted.

Sect. IV. The Firf ObjeEtion anfwer'd, namely, That we have no Parents in the Refurrection.

But to proceed; we muft not fop at this Objection, which to underftanding Perfons is too Vulgar, viz. That the Refurrection does therefore feem incredible, becaufe when we came into the World we had Parents to whom we owed our Birth, and that there were fo many proper Means at hand upon that Occafion, but that the fame
will all be wanting at our fecond Birth or Refurrection.

Since all that a good Logician can prove from thence is, that there is a Power and Wifdom capable of providing Means for the Procreation of human Creatures after this manner. Now what Reafon can be given, that the fame Power which has been able to do this after one manner, cannot make ufe of other Means for the fame Purpofe? The rather, fince we fee that God, to manifeft his Wifdom likewife to thofe that hate it, is wont to execute the fame Purpofes in numberlefs Ways and Methods. It would be unneceffary to repeat Inftances here of all kinds of Animals, having done the fame largely in the beginning of the XXII. Contemplation, where we have given an Account of their Motion, Nourifhment and Generation, in refpect to which the Inftruments of each kind of Fijpes, Biids, and Beafts are almolt all differing from each other, and yet they are all procreated, nourifh'd, and do move themfelves from one Place to another.

So likewife when we contemplate the Plants, how various are the Ways of putting forth and growing among them? Some grow in Earth, and that oftentimes in one only determinate and particular fort; others require another kind of Soil; fome grow upon the Water, and fome even under Water; one in a warm Climate, and another in a cold; fome are propagated by the Seed; fome by a Branch taken off from the main Plant; a third by Setting ; a fourth by Grafting ; a fifth by many of thefe, and perhaps yet different Methods: And thus are the Views of ${ }^{\prime}$ the Great Creator, of caufing Plants to continue in their Kinds, executed after fo many different Ways.

This being fo, what Impoffibility is there, that the fame Power which produced the Bodies of

Men once before by the Means of their Parents, may not perform the fame again by other Means? And if we only fuppofe, that this Great Maker can ufe as many Ways as all Men can invent (wherein neverthelefs his Power does far exceed all human Inventions; as is plain to thofe that are, wont to inquire into his Works, where they daily learn fomething new, that perhaps never before entered into their Thoughts) no body will eafily deny the fame; forafmuch as he would pafs but for a poor Philofopher among the Atheifts, who thould not imagine himfelf capable of forming an Hypothefis, whereby human Bodies, by a different Difpofition and Motion of Parts might be produced after a different manner than now they are.

Sect. V. The Second Objection, from the Smallnefs of the Parts after Corruption, anfwer'd.

Those that deny the Refurrection do again think the fame impoffible, becaufe our Bodies being diffolved by Corruption into fo many and fo fmall Particles, it does not appear credible to them, that they can be all again replaced in their neceffary Order, nor the proper Body thereby reftored to its former Figure. But will they therefore doubt, whether a good Anatomift can put all the Bones of a Skeleton, or a good Clock-maker all the Wheels and Pieces of a Watch, tho' jumbled together without any Order, into the fame Structure again, fo as to compofe the very fame Skeleton and Watch? If therefore we do but fuppofe, that the Great Creator of the Univerfe is endowed with only fo much more Wifdom and Power than an Anatomift and Clock-maker, as the Structure of a human Body is more noble and curious than a Skeleton or a Watch, what Bifft
culty can there yet remain? For that we do not herein afcribe too much to that Adorable Being, but on the contrary think of him much too meanly and below his great Perfections, by, fuch a Suppofition, may appear from hence; that if all the beft Workmen in the World fhould lay their Heads together, there would not be Wifdom, enough in them, (to fay nothing of their Power) to put in order the Body of a Flea, or any other Infeet, or even any little Seed of the. fmallef Plant, fo as to compare for Excellence and Contrivance with any one of thofe which we daily obferve to proceed by Millions out of the hand of this Great Artificer. The rather becaufe, as has been hewn before, the moft minute Particles, even thofe of Light itfelf, are governed by a Power which extends itfelf to all things, and they are fubject to certain and fixed Laws, even when they appear to be in the greateft Diforder. Having often feen the Pitture of a Man fo accurately formed upon a white Cloth, or Paper, in a dark Chamber, it occurred to my Mind as an agreeable Type of the Refurrection ; at leaft it appeared from thence, that the Rays of Light reflected from the real Body of a Martutanding out of the Chamber, pafs through the Air mingled among numberlefs others that proceeded from circumjacent Objetts, and yet, after entering into the Chamber, were feparated from all the foreign ones, and collected into the exat Image of the fame Man, according to the Laws of Dioptrics.

If now all thefe Particles of Light, after fo many Mixtures with, or Percuffions againft other Particles, can be oblig'd fo frietly to obey certainLaws, that when received upon a white Paper, and regularly collected, they will paint and exprefs the juft Form of that Perfon from whom they proceed ; what Impofibility is there, that the Parts

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of a putrified Body, 'tho' mingled and difperfed among an infinite number of others, fhould be brought together again, and compofe the fame Boty, any more than that the Particles of Light do the Figure of it?

If this be not fufficient, our Reader may recollect what has been faid in the two preceding Contemplations, viz. that not only the fmalleit Animalcula, or Particles of Bodies, cannot efcape the Direction of the Glorious Maker and Ruler of all things; but alfo and chiefly, that before all greater Bodies do become Inftuments of his Power, he has thought fit, for the difplaying of his own Glory, that they fhould be firft divided and feparated into Particles of the extremeft Smallnefs, and fuch as can be farce conceived by Men. If then it be proved by undeniable Experiments, that there is a Power which has framed all things upon the Earth round about us, yea, even the great and glorious Body of the Sun itfelf, of fuch fmall Particles, and has difpofed them in fo wonderful an Order; how can the moft unhappy Sceptic, or Doubter of the Refurrection, pretend with Reafon to deduce any Argument from the unconceivable Smallnefs of the Particles into which a human Body after Death may be diffolved by Corruption or otherwife, againft the Poffibility of the Refurrection of fuch a Body?

Sect. VI. The Third Objection, from the Attrition of the Particles, anfwer'd.

But as the Eancies of fome, who wifh that all their Notions may be true, are rich in finding out plaufible Arguments in favour thereof; fo they endeavour to amufe themfelves with the Opinions of fome famous Philofophers, who maintain that cyery thing, efpecially the fmalleft, and confequently
quently the weakeft Particles, wear away with Motion; and therefore change both their Figure and Properties, fo that after a great many Years, and the paffing away of Ages, we do in vain feek throughout the whole Univerfe for thofe Parts of which a Body was compos'd, and of which, if they were to be found, it might be again compofed after the fame manner.

But he who contemplates the Operations and Laws that have already obtained in the World, will be conviaced;

Firft, That by the Art and Invention of Men, whereby they apply the Laws of Nature to their own Purpofes, even the whole Frame of the Bodies of Men and Bealts may be preferved, unchanged, and uncorrupted; it is therefore much more poffible, and likely too, that incomparably fmaller Particles may by an unconceivably greater Wifdom and Power be continued in their prefent State and Condition. Now that the aforefaid is true, will appear from the known Manner, after which fo many exotic Plants and Animals are fecured from Corruption in Spirits of Wine, refin'd from all their Water, with the Addition of a little Camphire ; as likewife from the embalming of Dead Bodies, as well by the Ancients, as particularly by the Moderns, who can much better fecure Bodies from Putrefaction. So likewife Simon de Vries, in his Defcription of OldGreenland, fays, that the Air is fo fharp, as to preferve dead Bodies from Corruption; and the famous Geographer Sanfon relates, that when a Spanil] Colonel marched from Periu to Chili, over a high Mountain, fome of his People were frozen to Death; and that feveral Years after, he found them in the fame Condition, that is to fay fitting upon their dead Horfes, and holding their Bridle faft, their Bodies remaining uncorrupted.

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Secondly, That all Things do not wear away and change their Figures indifferently, has been already fhewn in the XXVI. Contemplation, Sect. V. fince if it were fo, Water, Air, and the whole World in all its Patts would be changed as to their Nature and Properties, juft contrary to what Experience teaches us.

And if any one defires to be convinced thereof, by an Experiment, which I had made with another view, in order to fhew, that the Temperating of Acids (as it is called in the Language of the Phyficians) does not confift fo much according to fome, in the obtunding or blunting the acute Parts of the Acids themfelves, as in their ftrict Union with Alcali's, either Watry or other Parts; let him firf diffolve Silver in the Acid Spirit of Salt-Petre, or otherwife in Aqua fortis, and then after having put a little Water to it, lay a Plate of Copper in the faid Liquor, whereupon the Acid will let the Silver go, and diffolve the Copper. But if you throw in fome Iron, the Copper is precipitated, and the Iron diffolved by the Spirit, which being filtrated again by the Addion of fome Lapis Calaminaris, the Aqua fortis quits the former, and diffolves the faid Stone. If then you fhould pour off this Liquor from all that has fubfided in it by Filtration, and then put fome Lixiviate Salt of Tartar to it, this laft will be diffolved and precipitated, and the Salt be united with this Menfruum; fo that this mixture being Chryftaliz'd, (which is a Sign, that the Parts of the Nitrous Spirit remain unchanged, will yield a burning Salt-Petre.

And to fhew farther, that it preferves its Acidity, I put frefh Water and Oil of Vitriol to the aforefaid Salt-Petre; from whence by Diftillation, I produced again the fame Aqua fortis, or Spirit of Nitre, which upon tryal, difcovered

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its Acid Qualities; for when we threw into it fome unrulted Filings of Iron, I obferved the Iron to be diffolved, with a great and violent Effervefcency, and a very red Vapour to afcend, which is peculiar to a Nitrous Spirit. This was yet more ftrongly confirmed, by putting fome Salt of Tartar to it again, by which means, there refulred the fecolnd Time a good Salt-Petre from, the faid Spirit: From which Experiments it does appear at leaft, that this Nitrous Spirit, after fo many, and fuch different Unions with Silver, Copper, Iron, Calamine-ftone, and Salt of Tartars and after having twice refiited fome of them, till remained in its formet Condition, the Particulars thereof being neither changed nor worn by all thefe Motions; which hews it is by no means impoffible, that the fame Power which preferves to the Spirit of Salt-Petre its Figure and. Properties, after fo many Unions, Mixtures and Effervefcences, may likewife do as much in the Parts of other Bodies. Thus we alfo fee Quick-filver and Gold handed numberlefs ways by the Chymifts; and yet continue the fame, after having undergone fo many Changes.).
$S_{\text {Ect. VII. The Fourth Objection, from the Union of }}$ thefe Particles woith otber Bodies, anffuered.
Another Objection is wont to be made by fome, againt the Poffibility of a Refurrection, becaufe, that not only all Bodies are divided into fuch fmall Particles by Corruption and other means, but chiefly becaure thefe Particles become united, or ratherchanged into other Bodies ; and the Earth, which for inftance, proceeds from a Putrify'd Car$\mathrm{ca}_{2}$ Is of Man or Beaf, is of ontimes tranfmitted into many kinds of fluid and folid Bodies, fuch as Water,Air, Trees,Plants, and Herbs; fo that there feems
feems to be neceffary here, not only a bare Union of thefe divided Particles, but likewife, Fir $\ell_{3}$ A Separation from thofe Bodies wherewith they were united; which to thefe Objectors feems incredible, and hardly poffible in fo many Millions of Cafes, in which all this would be requifite towards the raifing of one only Body again.

But thofe Gentlemen would eafily pafs to other Opinions if they were reafonable; upon our frewing them what they look upon as incredible, is brought about many. Ways in Chymiftry, both in refpeat to Solid, as well as fluid Bodies.

If one put Silver into Aqua fortis, it will be diffolved therein, and turned to a fluid Matter; add a little Copper, and the Silver will be feparated and fink to the Bottom, as we have fhewn before.
Melt Gold and Silver together, and when they are cold, they will become a hard mixed Metal; but throw that Mixture into Aqua fortis, and they will be immediately feparated, the Silver incotporating itfelf with that Liquor, and the Gold fubfiding like a Powder to the Bottom; as is well known to all that deal in thofe Metals.

The Oil or Salt of Tartar being diffolved in Water, and boiled with Sulphur, will unite itfelf therewith, but pour a little Vinegar into it, the Salt of Tartar will mix itfelf with the fame, but the Sulphur will be feparated.

Mingle Spirit of Sea Salt with fome Volatile Sale, for inftance with that of Harts-horn, and they will unite themfelves clofely to each other; but add fome Pot-Ah or Chalk thereto, and they will prefently quit each other, and the Spirit of Salt will join its felf to its new. Gueft. It would not be difficult for thofe that are well vers'd in Chymiftry to produce innumerable other Examples of Matters that adhere and unite clofely trith

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one another, which yet are eafily feparated by the Addition of the Third. And if it happens fo in thefe Cafes, where is the Impoffibility in any other Matters?

Sect. VIII. The Fifth Objection, That in the Particles of Bodies, we cannot objerve any Such Union, anfwered.

Butitmay be, our unbelieving Philofophers will reply, that we cannot obferve any fuch uniting Properties in the Parts of human Bodies, and that therefore there is no fuch Thing.

But if they would pleafe to attend to other Chymical Experiments, they might fee that Water and Oil being put together, will not unite, but remain unmixed; but if you fhould join the fame Oil with Pot-Afh, and Salt of Tartar, or any other good Lixiviate Salt, (or even fome Oils with Sugar) and make it into Soap, it will eaflly unite with Water.

Copper is likewife indiffoluble, and will hardly be touched by common Water; but if you add thereto fome Volatile Salt of Sal-Armoniac, the Copper will be entirely diffolved, and turned into a blue Liquor.

Refin made of Drugs, fuch as Fallop, Scammo$n y$, \&cc. cannot be feparated in fimple Water ; but add to them Yolk of Eggs, or pounded Almonds, and they will be eafily mixed together; from whence, as alfo from a great Number of other Experiments which we might borrow from the Chymif, it is plain, that tho' two Matters will not unite, the fame may be brought about by the Addition of a Third: And having fhewn this in fo many Cafes, what Impoffibility is there again, that the Material Particles of our Body, according to the fame, or other Analogous Laws of

Plants and Animals wherewith they have been unired, may after a Separation be joined again, as they were once before ?

Sect. IX. The Sixth Objection, That thefe Particles are Scatter'd too far from each other, anfwer'd.
If any Body that feeks for farther Evafions, fhould hereupon reply, that thefe Particles before they can be united to others, mult firft be brought very near together ; but that between thofe of our Body, there are oftentimes found very great Di flances, and that their Union is thereby prevented; let him confider, that tho' Acids and Aicali's muft come very near, before they can lay hold on each other, yet Amber, Wax, Glafs, will attract Straws, and other light Matters at a much greater Difance, only by being a little rubbed; that the Load-Stone draws Iron, tho' it be yet farther off, and that whatever is counted heavy upon the Earth, moves, or is attracted towards the Centre thereof; not to repeat here that which muft be fuppofed, according to the Opinion of Sir Ifaac Newton, and whereof we have given a Proof above in the XXVIth Contemplation, viz. that even the Heavenly Bodies at their great and almoft immeafurable Diftances, are fubject to a Law that brings them towards each other. If then it appears from hence, that fuch great Bodies gravitate or move towards each other according to the prefent Laws of Nature, tho' at fuch great Difances, and as far as their Motion will permit, do unite with one another; why fhould it be impoffible for the fame Power to do this in Human Bodies?

[^5]Sect. X. The Seventh Objection, That the Particles of Matter would aEt with Choice or Knowledge, anfwer'd.

There is another Objection, namely, that the Particles of our Body might feem to ad with Juidgment and Election, if among fo many Millions of others they fhould juft meet at the fame Places of the Body to which they belong, and concur with them in forming a new Structure.

Yet this is no greater a Wonder, than that among fo many other Places where the Particles of the Earth, Water, Light and Airmight fix themfelves, thofe that are proper to produce Grapes, do only unite themfelves to Vines; thofe of Apples, to Apple-Trees; fuch as belong to wholfome or unwholfome Plants, are united after the fame manner ; and notwithftanding that the moft poifonous Herbs grow near, or in the midft of a great quantity of Corn, this laft will not be affected thereby.

The like may be obferved even in our own Bodies, where from a mixed Chyle confiting of fo. many kinds of Meats and Drinks, thofe Pärcicles are only join'd to each Part of the Body where they are wanting for the fupport of the fame; by which Direction it comes to pafs, that Flefh, Bone, Membranes, ©́c. do all remain unmingled, and in order; without which they would otherwife be foon uncapable of difcharging their Functions.

And to give other Inftances, of which we may find a great many-in Chymittry; mix Iron, Lead, Salt and Stone, all of 'em reduced to a Powder, rogether; then hold a Load Stone near it, it will draw the Iron only, and as it were by free choice out of this Compofition, leaving all the reft of the

Matters untouched : Pour Quick-Silver upon this Powder, it will anly embrace and unite its felf to the Lead, neglecting the reft; put fome Water to it, that will only imbibe the Salt, and let all the reft alone. The Doctrine of the Menftrua or diffolving Liquors, will furnifh us with a great Number of other Inftances, wherein each atts upon its proper Object, as it were by free Choice and Knowledge.

Now there is not more required to the Renovation of our Bodies from their Atoms or Particles, than what we fee in thefe Matters.

Sect. XI. The Eighth Objection, Concerning Canibals or Men-eaters, anfwer'd.

Bur the Hiftories which we read of Men-eaters; feem to be of fome Weight with thofe who would infinuate this Notion of the Impofibility of the Refurrection into the Minds of weak Men : Since when one Man is devoured by another, the Confequence would feem to be, that as one is turned into the Food of the other, his Body would likewife be changed into the Body of the other; and forafmuch as it is an Article of the Chriftian Faith; that each one fhall rife with his own Body, they think they can prove it to be impoffble in this Cafe; becaufe, tho' the Body of the Canibal fhould be raifed in all its Parts, yet that of him who was devoured, will be deprived of feveral.

Now to remove this Difficulty ; thefe Objector's muft be forced to own, that two Cafes may come to pafs therein. The Firft is, when the Canibal lives fome Years after the Perfon he has devoured, for in this Cafe it is clear, that the Objection will fall to the Ground, becaufe, according to the common working of Nature obfervable in all Bodies, that which now tends to Food, and to Sff2 compole at every Meal, fhould be converted into the Matter of his Body, there would be added every Year 20 Pound to the Weight thereof, and Confequently in 50 Years, it will amount to above 1000 Weight; whereas we find it otherwife by Experience: From whence we may conclude, that as the Body becomes heavier and bigger by Food, it does at the fame time grow lighter and lefs by Perfpiration, and other Motions of the Fluids, as Sanctorious has firt obferved.

If now we fuppofe the Second Cafe, and in order to make all the Conceffions that are reafonable, allow that this Canibal or Man-eater does die at fuch a time as the Objector himfelf thinks fit ; and that the Flefh of the Perfon devoured is united to the Body of him that eats it: This Objection may feem at firf fight to thofe that have not much contemplated the manner of God's working in Nature, to carry fome Force with it.

But let thefe Objectors confider, that altho' the Maker of a Human Body permits fo many Things to come to pafs therein with our Knowledge, and at the command of our Will, jet he excepts the Nourifhment of the Body out of it, that being performed not only without any Power of the Will, but even without our Perception or Knowledge : Since after that the Food has paffed thro' the Stomach and Bowels (where indeed fometimes we have fome Perception thereof) no Body knows what becomes of it afterwards, nor with what Patts, nor at what Time it is united : Shewing thereby, that this Benefit which is procured to us by the taking of Food, depends perfectly and and only upon his Will. We fee likewife that fome fickly Difpofitions, as alfo too great Heat, too violent a Motion, too great a Paffion, which laft are not wont wholly to deprive us of Health like bodily Diftempers, are oftentimes the occafion that our Bodies are not nourifhed by the Food that is ufed, fo well as at other times.

From whence it is probable, that if the Defign of the great Creator of all things be, that every Man fhould Rife with his own Body, as he has declared to us in his holy Word ; 'tis likewife in his Power to hinder, that no one Particle fhould effentially belong to two Bodies, and that even, after a natural manner, there is no lmpoffibility in it.

But if this Argument fhould not appear fufficiently convincing to fome, they may be affured thereof by numberlefs Chymical Experiments; by which it will appear, that tho' a Body has the Property of uniting itfelf to another, yet it can be hinder'd by the Addition of a third, and by other Ways too from doing the fame.

Thus Spirit of Salt-Petre will unite with Steel; but if one firft puts into it a fixed Alcaline Salt, fuch as that of Tartar, the aforefaid Effect will be prevented.

A Lixiviate Salt will mix with Oy , and turn it into Soap; but put a little Vinegar to it, or any other acid firft, and the Salt will not Incorporate with the Oyl ; and even when the Mixture is actually made, they will be divided and feparated thereby.

Iron will join itfelf to the Load-Stone, or rather they will move towards each other; but turn them only the wrong way, and they will fly from, or drive one another away. But to Inftance in no more Cafes, as one might eafily do from Chymiftry, who can give any Reafon why

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the fame Power that does all thefe Things, cannot bring about the fame Effects in the Parts of a Man, whofe Body has been united as Food to the Body of a Canibal?

SEct. XII. Convittion and Poffibility of a Refurrection.

IK Now very well, that fome ingenious and acute Philofophers may not be at a lofs to fancy Hypothefes, in order to folve the Caufes of all thofe Experiments we have produced, and it may be fuch as may feem to have fome Analogy therewith; and that even all the chymical Phænomena are accounted for, by one this way, by another, that; but it is not neceffary either to admit or to reject the whole : Firft, becaufe we do not here undertake to inquire into the Truth of thofe Principles, upon which each Man builds his Syftem of natural Knowledge. Secondly, Becaufe it is fufficient to our Purpofe if the Experiments be only true, let People deduce them from fuch Caufes, as they fhall judge moft confiftent with their own Hypothefis: Forafmuch as no Body can pretend to prove from fuch Pores, fuch a Figure, fuch a Determination of Motion, fuch an attractive Force in the Parts of Matter (from which Principles moft Caufes are derived in this Age) whether it be poffible that each of thefe are likewife to be found in others; and that the fame Bower which has adapted the firft to thefe Properties, does likewife do the fame in others, by changing them every time according as it fhall judge it to be moft ferviceable to its great Ends and Purpofes.

Sect. XIII. Iranfition to another kind of threefold Objections.

I Might have made an end here of the Proof of the Poffibility of the Refurrection in the fame proper Bodies, were it not that fome Atheifts pretend to defeat the fame after other manners? Namely, Firft, by unadmittable. Confequences, which they think they can draw from thence. Secondly, By the fuppolition of Things that are poffible, which notwithftanding, the Refurrection of the fame Bodies makes impoffible according to their Notions. Thirdly, by comparing the Bible with it felf (from whence all Chrittians prove the certainty of their Refurrection) and by quoting fuch Texts out of it, which, as they would make us believe, feem to have very little agreement with a Refurrection in the fame Body.: And I hope we fhall not appear tedious to the Learned, if we fill add fomething here to obviate thefe Difficultics, efpecially if we ufe no other Proofs therein, than fuch as are founded upon daily. Experiments.

SECT. XIV. Three Objections of the firft Kind.
The Firft Confequence then, which they think muit appear abfurd and unadmittable to every one, is, That in cafe the Refurrection be made in the fame proper Body, a Child dying foon after its Birth, will rife again likewife as a Child' and with an imperfect Body.

The Second is, That if any one whilf he is yet a Child, lofes a Leg or an Arm, and lives afterwards fome Years, and grows bigger, he muft believe that when he dies, he fhall rife again maim'd, and without Arm or Leg; or in cafe his Body be fupply'd with thofe Limbs that are SCf4 : wanting

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The Ihird is, That if a Man is to rife'with his own Body, it feems, to them a neceflary Confequence, that almoft all Bodies will be entirely rpent and wafted, and much fmaller and lighter than they ought to be naturally at the RefurreCtion: Since moft Men before they die, fall away fo much through Sicknefs, and fome are fo exceedingly wafted by Confumptions, as to fall far frort of that Weight and Size which belong to cheir Bodies in Health.

## SECT. XV. Objections of the fecond Kind.

N o w the Fourth Thing which they Object, and which, tho $0^{\prime \prime}$ poffible in itfelf, they think the Belief of Chriftians renders impoffible, is the following : If a Canibal or Man-eater fhould live a number of Years, and in all that time fhould ufe no other Food than human Flefh, it feems impoffible to them that both the Canibal himfelf, and at the fame time all that have been devoured by him, can rife again with their own perfet and proper Bodies.

SEct, XVI: Objections of the third Sort from the Holy Scriptures.
Now the Objections which they themfelves produce from the Holy Scriptures, are firf, fuch Texts where exprefs mention is made of a Refurrection in the fame Body; as $70 b$ xix. ver. 26 , and 27. Tho' after. my Skin Worms deftroy this Body, yet in my Flefh fall I See God, whom I ball See for my Self, and mine Eyes Sball behold, and not another. And Paul, Rom. 8. ver. I 1. He that raifed up Chrift from the Dead, Jall alfo guicken jour mortal Bodies; as al-
fo Phil. iii. ver. 21. Who Jhall change our vile Body, that it may be faffioned like unto his glorious Body. We flall not repeat all the reft that are of the fame Tenour.

Againft thefe Texts they oppofe fome Expreffions of the faid Apoftle, I Cor. xv. ver. 35, 36 , $37 ; 38$. which they think cannot be underfood confiftent with the former; for when before, he introduced an Objector ufing thefe Words, ver. 35. But fome Men will fay, how are the Dead raifed up? and with what Body do they come! He anfwered the fame by a Comparifon of a Grain of Corn, ver. 36. Thou Fool, that which thou Soweff, is not quickened except it die; ver. 37. And that which thou Soweft, thou foweft not that Body that Sall be, but bare Grain, it may chance of Wheat, or fome other Grain. ver. 38. tut God giveth it a Body as it. hath pleafed him, and to every Seed his own Body. From which Words therefore they conclude, that we fhall not affume at the Refurrection the fame Bodies which are put off at Death; but that they will be other, and different, and fuch as God gives according to his Pleafure. So that according to them, this Text feems to contradict the former, and likewife itfelf, becaufe if a Man fows any Thing elfe than the Body, that fhail be, and that God gives to the thing fown, a Body as it bath pleafed bim, 'tis impoffible in their Opinion to be the fame Body of that Seed.

Befides this, fome of 'em urge other Difficulties againft a Spiritual Body, ver. 44, and 46. and efpecially becaufe in ver. 50 , it is faid, that. Flefto and Blood cannot inherit the Kingdom of God. This feems to them contradictory to the former Pafiages quoted from $70 b$.

Sect.

Sect.XVIII. Our Defigh bere is not. to defcribe the Man ner. of the Refurrection, which we muft leave to God.

Beforei pafs on to anfwer there Difficulties, Ifind my felf obliged, for the Inftruction of fuch Chriftians as may happen to read this, to premife :

1. That our View here is not to account for the Manner of the Refurrection of the fame Body, which great Myftery we muft leave to the Wifdom and Power of God only; nor have we undertaken any Thing more, than to fhew that fuch a Refurrection involves no Impoffibility in it; and that the foregoing Objections raifed by fome Atheits, even from the Holy Scriptures, in order to footh and quiet their own Confciences againft the Terrors of this Refurrection, may be eafily cleared up and removed, from what we find daily paffing in the World by our own Experience.

Sect. XVIII. A General Anfwer to all the ObjeEtions againft a RefurreCtion, takein out of Scripture.
II. To return a general Anfwer to all that thefe unhappy Cavillers, and deplorable Biblereaders (I mean fuch as only fift the Scriptures to difcover Abfurdities therein, as I have known fome fuch) fancy they have found in that holy Word, which they can neither reconcile with their own Notions, nor with other Texts that treat of this Refurrection. I fay, nothing more is required to anfwer thefe People, than what we find to be exprefly affirmed in the faid Scriptures; namely, that in order to underftand the true How, and other Circumftances of the Refurrection, we muft according to the before-quoted Reply of our Lord to the Saducees, not only know the Scriptures, but Ijkewife the Power of God, if we would not Err.

[^6]Sect. XIX. A bare Hypothefis is fufficient to herw the Podfibility of any Thing.

To difarm the Atheifts as much as poffible of all their Evafions, it is neceffary to add, that tho ${ }^{2}$ what we fhould hereafter produce from natural Obfervations, could not be demonftrated to be frictly true, but were only a fimple and naked Hypothefis, it would carry with it perfectly the fame Weight and Force in this Matter. Since to prove the poffibility of any Thing, there ought not to be more required from him that afferts it, than only to find out an Hypothefis containing the manner how it may come to pafs, and which includes no Contradiction in it. I don't think that any Atheift will deny this, fince it is own'd by the chiefeft of their Sect. To begin then,

Sect, XX. There is a Proper or Own , and a Vi fible Body.
I. Every Man has befides his Soul, a Body, which for fo far as it can be feen by all, we fhall exprefs by the Name of a vifible Body.
II. This Body may be termed, in refpect to thofe of other Men, one's peculiar or particular Body, fince a Man is thereby diftinguifh'd from others, and it is the Compofition of this particular Perfon, and no other.
III. But fince this vifible and particular Body does undergo very many Changes, and according to the Difference of Years, and to the good or bad Conflitution of a Man, and otherwife, becomes fmaller and greater, leaner and fatter, lighter and heavier ; and that it is even poffible

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that one and the fame Matter may now belong to the vifible Body of one Man, and afterwards to that of another; as for inftance, if the Blood of one Man, by a Wound or otherwife, fhould be fiilt upon the Earth, the Matter of it might ferve to feed fome Plant or Fruit, which being afterwards eaten by another, contributes to the Increafe of his vifible Body: And fince, notwithftanding all thefe Changes, every vifible Body does fill remain the Body of the fame Perfon, it is apparent that there mult be fomething in the vifible Body which undergoes fo many changes, from whence it has a Right to be always denominated the own Body of the fame Perfon, of which Term we fhall likewife make ufe in the following Difcourfe, in order to make a Diftinction between the own and vifible Body of every Perfon.
IV. And thus it is plain, from what has been faid, that there is an effential Difference between the own and rifible Body of a Perfon; fince many Parts of the laft can be joined to, and feparated from it, and even belong to more vifible Bodies than one; but the own Body remains fix'd and determined to one and the fame Perfon only.

SECT. XXI. This Diftinction is acknowledged by all.
V. An D that none may think that this DiftinCtion between a vifible and an own Body is invented by us, and has no Foundation in Truth; it is known that if one fays of a Man, that he weighs 200 th. nothing elfe is underfood thereby, than that it is his vififle Body which is of that Weight; but if one fays, that fuch a Man is 80 Years old, it can only be meant of the own Body, fince all the Food that he has ufed in the laft 10,20 , or 30 Years of his Life cannot be faid to have appertained

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## tained to his vififle Body the whole Space of 80

 Years.SEcT. XXII. The vifible Body conffes of Fluid and of Solid Parts, and of Laws.
VI. Now to inquire wherein this own and vifible Body does determinately confift, it muft be confers'd, firft, that this oren Body which helps to compofe the Perfon, is not the vififble Body wholly and folety; See [Numb.IV.] it muft therefore be contained within the vifible Body.
VII. This vifble Body confifts :

Firf, Of Fluid Matters, as Blood, Whey, Lympha, Chyle, and Milk in Women that give fuck, and Water in which the Embryo lies in thofe that are pregnant ; various kinds of Glandular Juices from the Pancreas, the Glands of the Stomach and Inteftines, Gall, Spittle, Sweat and perfpiring Matter, Tears, Snot, Nervous Juice, and others, that have yet no particiular Name ; to which fome add, Fat, the bitter Matter in the Ears, that in the Seminal Veffels and the like, tho' they are fomething thicker than Liquors or Fluids.

Secondly, Of Solid Matters, Flefl, Bones, Nerves, Membranes, the Teeth, or $_{\text {c }}$. The modern Inquirers reduce them all to Bones and Nerves, as we have obferved already in Contemplation XI. Setz 17.

Thirdly, Each viffle Body, whilft it is alive, has its particular Laws; thus there are Laws in Human Bodies, according to which are regulated the Confumption or Digeftion of the Food in the Stomach, the Separation of the Chyle from the groffer or excrementitious Matters, the Sanguifcation or Converfion into Blood, the Separation
of the Humours, the Motion and Nutrition whereby the faid Blood is turned here into Bones, there into Nerves and Tendons, in another Place into Membranes, $\mathcal{d} c$. befides Generation and Production. According to thefe Laws, we fee that when a Piece of Bread is eaten by a Man, a Dog, a Fowl, and a Carp ; in the three firt it is turned into different kind of Flefh, in the laft it becomes Fifh ; and the fame Food makes a white Skin in an European, and a black one in a Moor, as it makes one Man fat and another Man lean; and we find that Children ufing the fame Food are fubject to the fame Laws; that the Stomach of one digefts with Eafe and Pleafure, onekind of Food, as the Stomach of others does another.

Sect. XXIII. The own Body conffits, in a manner, of no Fluid Parts, nor of Lawws, but almoft only of Solid Parts.
VIII. So then the own Body of a Man muft confift of one or more of thefe three, Fluids, Solids, and Laus.

It does not feem to confift of the Fluids, fince many of them are changed, become more or lefs, and may be intirely feparated from the Body, whilft at the fame Time it fhall remain the proper and own Body of the fame Perfon: Thus the Blood daily diminifhes by the Separation of Humours, and by Perfpiration, and is as daily increafed by a new Chyle; not to mention great Effufions of Blood both in Men and Women; of the laft of whom, I knew one who in a few Years had loft much more Blood than the Weight of her whole Body was equal to; now whether it was a Blood confifting of this or that Matter that flowed thro' her Veins, her Body remained unqueftionably the fame proper Body.

Now fince the Blood does not belong effentially to the proper Body, neither can all the Hu mours that are feparated from it, be counted to belong to the fame, forafmuch as they are daily changed; thus Fat is diminifhed by Leannefs, and other Fluids by other Means, from thence we may conclude, that hardly any, at leaft very little, of the Fluids, are neceflary to the Compofition of what we call the own body.
IX. Now that the Laws likewife do not belong effentially to the own Body, is apparent ; Firft, Becaufe the fame are frequently changed in the fame Men, whilt they remain in the fame Perfons: Thus Experience teaches us, that fick and healthy People, young and old, are not fubject to the fame Laws, which holds true both in Men and Women. Secondly, The fame may be inferr'd, not only becaufe the Body is material, and the Laws do only confift in certain Motions and Properties, but particularly (which puts the thing paft all doubt) becaufe a dead vifible Body, in which it cannot be faid, that there Laws do any longer prevail, is as much efteemed to comprehend the oun Body of the deceafed Perfon, as when it was living.
X. Lastly, Since it plainly appears, from all the foregoing, that a Body may fill continue the own proper Body of the Perfon, tho' filled with Humours and Juices quite different from thofe it once had; and that fuch Fluids may be likewife moved by quite different Laws, but even thofe Laws may alfo entirely ceafe when the Body is dead; we muft therefore only feek for this proper own Body in the fimple and naked folid Parts thereof.

Sect. XXIV. The own Body confifts either of a
Stamen or Principle unfolded only; or elfe of a Stamen, that grows and increafes by the Addition of Foreign Particles.
XI. Now to treat more clofely of thefe folid

## Parts:

It is very well known to thofe that are verfed in the Inquiries of the prefent Age, that as the Plants and Animals, fo likewife Man does confift of a firft Principle or Stamen, which may therefore be denominated the own Body, or at leaft fomething that contains the fame; as has been already thewn in the XVIth Contemplation.

The Parts of this Stamen are in the Growth of it, and from time to time expanded, or unfolded, and cloathed as it were, and filled up with other Particles continually, till the vifible Body of a bigger, and at leaft of a full grown Creature, refults from it.

Now fince this Stamen, during the Growth of a Body, is clad and ftuffed with other Matter in and about it, and fince it contains all the folid Part's of the Body in Proportion to its Bignefs, either this fimple expanded Stamen, without any other adventitious Matter, mult be admitted and allowed to be the own Body, or elfe the fame Stamen filled and cloathed with that Matter, which afterwards becomes Bones, Flefh, Ligaments, Membranes, ©c. fo far as thofe compofe the folid Parts of a Body, muft be reckon'd the orwn Body; oue of thefe is certainly true.

We fhall therefore, in both thefe Cafes, one of which muft needs beadmitted, endeavour to folve the Objections of Atheifts ; and firft, thofe which they are ufed to bring from Nature, and next from the Holy Scriptures.

Sect:

Sect. XXV. How a Man may be faid to rife agairs with his own proper Body, in the firft Cafe.
XII. $I_{F}$ it be fuppofed that the bare Stamens expanded according to the Bignefs of the Body, without the Acceffion of any other Matter, to fill and cloath the fame, be the own Body, and which is to continue fo in all Men from their Birth to their Death; there will be nothing more required, that fuch a Perfon fhould rife with his own Body, than that only this Stamen, feparately from the Particles that cloath and fill the Body, fhould remain, and be continued in its own little Subftance, and that the great Author of our Refurrection fhould, after Death, unfold, fill and cloath the fame into a vifible Body, with the fame Matter that belonged to it before, and in its Lifetime, when it was a vifible Body; or elfe with fuch other Matter as he fhall be pleafed to ufe: We fhall not fpeak of the altered or changed Properties and Faculties, fince they do not affect the Matter thereof, nor do change the own Body as to its Effence; but refer it to the Word of God, touching the fame.

Sect. XXVI. The own Body, tho' filled with other. Matters, remains the own proper Body of the fanse Perfon.
XIII. Before we proceed any farther, let me add two things that may obviate all Objections againft what has been lately faid.

Firft, That an own Body, tho' filled and cloathed into a vifible Body with other Matter that never belonged to it, does neverthelefs remain the own proper Body of the fame Perfon; nor does this want much Proof, fince any one that has fallen

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1056 The Religious Pbilofopber. away by Sicknefs or Pain, if after his Recovery he becomes bigger and fatter, and for that Purpofe has ufed Food that was never any part of his own Body, will always be reckon'd to have been the fame Perfon, and confequently to have been alter'd by becoming fo much more vifibly bigger and fatter.

Sect. XXVII. When any one dies, a great deal of that Matter which belonged to the vifible Body, will be feparated therefrom.
XIV. Secondly, That when a Man has lived fome Years, a great Quantity of that Matter which belonged to his vifible Body, may be feparated from it, and he fill remain the fame Perfon; infomuch that the own Body undergoes no Change by the Lofs or Acceffion of fuch Matter that helpt to make it a vifble Body.

To prove this, Let us again fuppofe a Man that is 80 Years old, and that weighs 160 Pounds, and who, reckoning one Day with another, after Breakfalt, Dinner, and Supper, unites but one Ounce every Day of the Food he ufes, to the fluid and folid Parts of his Body, in order to repair what he lofes by Perfpiration, and other Ways; according to which, without reckoning the Weight of his whole Body as foon as he was born, there would be 80 times 365 , which is 29,200 Ounces, or 1825 Pounds of nutritious Matter, that has gone towards the Compofition of his vifible Body in the Space of 80 Years; from which if we fubfract thofe 160 Pounds, there will ftill remain 1665 Pounds, which during his Life-time, when they were at firft nothing but Wheat, Rye, Fifh, Flefh, ©̌c. did not belong to his Body, but were quite foreign to it, and might have as well have gone towards the Compo

Compofition of any other Man's vifible Body, as of his; and which afterwards have feryed to nourifh his vifible Body for fome Time, and finally have been feparated again from it ; in all which Cafes none can deny that it has been the fame Perfon, and therefore always preferved his own Body, from which, what has been faid before is fufficiently demonftrated.

Sect. XXVIII. The three Objections of Sect. XIV. anfwer'd, in cafe the own Body confifts of a bare Stamen.
XV. Now to return a particular Anfwer to the particular Objections ftarted by the Atheifts, Sect. XIV, and XV. and which they pretend to raife from Nature, upon this Foundation, that the bare Stamen does only remain the own Body, and is only expanded or unfolded from itfelf into a larger Size, by extending the Parts of it farther from each other (of which an Example may be feen in the XVIIth Contemplation) there is no need of any other Argument than the following: - If a Child were to rife again as a Child in its own Body, the Matter ofits Stamen need only be preferved and be again filled up at the Refurrection by other or by the fame Particles by which it had been increafed before.

If a Perfon is to be raifed as full grown, the aforefaid Stamen needs only to be expanded after the fame manner as it would have been in the Life-time, and then filled up and cloathed with Matter, which, when it remained alive, and increafed in Bulk, would have ferved for filling up the fame; in which Cafe, every one muft acknowledge, that the fame Perfon would have rifen. again in his own proper Body.

The fame may likewife be faid, if any one that is now a Man, and had loft a Leg or an Arm in his Childhood, fhould die; for here it is only requifite, that that Part of the Stamen which was to compole the Arm or Leg, fhould be expanded, filled up, and cloathed, in Proportion to the bigger Body, as has been fliewn before concerning the fmaller.

Moreover, if any one dies lean and wafted, and at the Refurrection his Body is filled with Matter, which did either never belong to him, or otherwife, with fuch as had before filled up his own to a vifible Body, why fhould he, at the Refurrection, be lefs accounted the fame Perfon, and be reckon'd lefs to enjoy his own Body, than Fob is faid to remain the fame $\mathcal{F} 06$, and to have retained his own Body, as well, when by the Goodnefs of God he was reftored to his former Strength and Health, as when he was fo wafted, as to be able to fay of himfelf, Chap. xix. ver. 20. My Bone cleaveth to my Skin and to my Flefh, and I am efcaped with the Skin of my Teeth? Now it is very probable, that that which render'd his vifible Body bigger and heavier after his Recovery, confifted of fuch Food and Matter as did not before belong to the fame.

Sect. XXIX. The Objection in Sect. XV. anfwer'd upon the Same Foundation.
XVI. Finally, if now even a Canibal had, during his whole Life, fed upon nothing but the Matter of the vifible Bodics of Men, and it had only pleafed God to hinder that the Stamina of all thofe whom he had devouted fhould have been converted into Food, but that they fhould have paffed thro' his Body with other excrementitious Matter; what Impoffibility is there that
that the particular Stamen of each Perfon (which we here fuppofe to be the own proper Body) fhould be feparated from thence, and filled up again by other proper Matter, or, it may be, by fome that had ferved the fame Purpofes before, as well as other dead Bodies. For it has been already fhewn, in Numb. XIV. that when a Perfon dies after fome Years, there are always a great Number of Particles feparated from his Body, at the Time of Death, which had ferved before to the filling up of a vifble Body.

Thus likewife may the Stamen of the Canibal himfelf remain alone, without any of its expanding Fluids, and be filled up with others at the Refurrection, and he accordingly may rife likewife in his own Body. For who can deny that any Man, for inftance, that has lived twenty Years upon human Flefh, and after that, fifty Years more upon Bread, does not, in both thefe Cafes, retain his own Body? For which Reafon the proper Body of any Perfon does remain the fame proper and own Body, tho' filled up with other Fluids. See Sect. XXVI.

Sect. XXX. The vifible Body of a Man may be very much emaciated, and yet remain his vifible and own Body.
XVII. Now to pafs on to the fecond thing mention'd in $S e c t$. XXIV. and to folve the Ob jections of the Atheifts by this other Principle, that the own Body of a Man does not only confift of the fimple Stamen, but does moreover always comprehend fome of the filling and cloathing, Matters which adhere to the faid Stamen, altho ${ }^{\text {B }}$ what has been already mention'd be fufficient to demonftrate the Poffibility of a Refurrection in Tt what oever :

Let me here premife, that it is experimentally known to many, that the vifible Body of a Man may be extreamly emaciated, or become verylean, and yet remain his own, and likewife his vifible Body. Accordingly two Inftances, among many other, do particularly recur to my Mind; the firlt was of a Perfon who had before been very Mufculous and Flefhy, but was, without any vifible Feaver, fo exceedingly reduc'd by a Marafmus or Leannefs, that his Legs and Arms, and all his Body befides, appear'd to them that faw and felt him, to be nothing but Bones or a living Skeleton; his Skin was all over blackifh and very hard, cleaving almoft infeparably to the Bones; nor could we externally difcover the leaft Softnefs of any Mufcles, of which, notwithftanding, the folid Parts remained under the Skin.

The Second, who was likewife before a very corpulent and fat Man, upon the burfing of three Veffels in the Lungs, call'd by the Anatomifts Vomica Pulmonum (from the leaft of which, there proceeded by Coughing and Retching as much Matter as would fill half a common Bafon, and from the biggeft much more, in lefs than an Hour's time) was in a little while redu'ced to fuch a Leannefs, that his Flefh was quite wafted; and the fame was attended likewife with a continual Cough, which lafted even a great while after he was afleep. Notwithftanding which, both thefe Perfons afterwards recovered their Health to fuch a Degree, that the firft of "em was again plump and flefhy, and the other grew extreamly fat. I have related both thefe Hi ftories, becaufe no Body ever queftion'd, nor can it at all be doubted, that thefe Men, in both thefe fo different Cafes, were the fame Perfons, and that
their Fat as well as their Lean Bodies might and ought to be denominated their vifible and own Bodies.

Sect. XXXI. The own Body, tho' allowed to be a Stamen, with an Accretion of foreign Matter, confolts of nothing elfe but of folid Particles, and chiefly of Bones.
XVIII. Before we proceed, it muft be here again obferv'd, that the own Body of a Man, tho' confifting of a Stamen, increafed with other Matters is, as has been already hinted, only compofed of Solid Parts; forafmuch as the Fluids and the Laws are daily changed, and the laft of 'em do entirely ceafe at the Time of our Death.

Moreover, fince a vifible Body, tho' reduced to fuch a Leannefs as we have juft now fhewn, may continue to be the vifble Body, having never been entirely deprived of its Fluids during its Leannefs, the own Body muft be ftill lefs in Matter than the emaciated vifible Body.

Finally, that this own Body does confequently confilt of nothing elfe but Bones and Nerves, of which likewife the Membranes, and of them the Tubes of the Flefh are compofed, (See Contemplation XI. Sect. XVII.) and the faid Flefh, when the Blood and Humours are feparated from it, is fo very fmall a Part of the vifible Body, that it can hardly be feen, nor even felt externally in the greateft Leannefs; fo that from hence it appears, that the real own Body does chiefly confift of mere Bones.

SECT. XXXII. The Three Objections mentioned in Sect. XIV. folved upon the Suppofition, that the own Body does confift of a Stamen increafed to a certain Bignefs.
XIX. Now in order to folve the former Objections likewife from this Second Principle, of which mention has been made in Sect. XXIV. Suppofe a Child to die, if it be to be raifed again as a Child, it is unqueftionable that it puts off by Death its own Body in the vififle one.

If it be to rife as a full grown Perfon, it is certain that no Atheift can deny, but that this own Body of the Child would have been filled up and cloathed with other Matter that never belonged to the fame, if the Child had lived to Man's Eftate, and yet it would have remain'd the owir Body of this Perfon. Now in cafe the Body of fuch a Child fhould at its Refurrection be increafed with the fame Matter which would have been made ufe of if it had remain'd living; what Reafon can there be to affirm, that fuch a grown Body would not have been the Child's own Body in the one Cafe as much as in the other ?

The fame Thing may likewife be apply'd to a Perfon, that in his Youth has loft a Leg, or an Arm, or any other Member; as likewife to thofe Objections, that mof Men mult rife again with meagre and wafted Bodies. Forafmuch as we have fhewn above, Sect. XXX. that not only a Body almoft utterly emaciated, but alfo in the Cafe of $70 b$, the fame Body fill'd with other Fluids (fuch as never belonged to it before) may remain the vifible. Body of the fame Perfon; and no reafon can be given, why that which happens at the Refurrection to a Body emaciated by Sicknefs, may not likewife be apply'd to a Body fill d
fill'd with Parts that render it much more beautiful, and denominate it the own and vifible Body of the fame Perfon ; the rather, fince fuch a Repletion or Augmentation may likewife be made with fuch Matter, which even had ferved before to the filling up of the fame Body in its Lifetime ; of which, at the Refurrection, there will be at hand a great Quantity, and more than is neceflary. See Sect. XXVII.

Sect. XXXIII. The Objections: of Sect. XV. anfwer'd from the faid Principles.
XX. Finally, to return an Anfwer to the Difficulty which thefe deplorable Philofophers think impoffible to be folv'd, and which they fetch from the Example of a Canibal, who was fuppofed to have devour'd a great many Men, and to have ufed no other Food: Thefe Gentlemen are defired to obferve in the firf Place, that the Foundation of their Miftake confifts herein, viz. That the Body of fuch a Man-eater can be nourifh'd as well by the own as vifible Body of one or more Perfons, the contrary whereof is true.

To prove this, can a Canibal fupport his Life (not to fpeak of his Health) therewith, if nothing but fuch emaciated Bodies as we have defcribed above, were allowed him for Food? Can he likewife eat Bones that are withered to a greater degree even than fuch as are dried in the Sun ? Can he be nourifhed with Nerves and Membranes entirely and perfectly divefted of all their Juices? For a vifible Body, though never fo much emaciated, can neverthelefs be in no fenfe efteemed an own Body, as long as there are any Fluids therein, as we have fhewn above, Sect. XXII, and XXIII.

On the contrary, daily Experience teaches us, that what we make ufe of for Food does belong only to the vifible Body of an Animal, and the Fluids that are therein. Thus we know that the Gravy of Roaft-Meat, and the Soup of that which is down-boiled, yields a very hearty Nouriffment, but that the folid Particles belonging to thofe Bodies upon which we feed, are feparated from the Nutricious Juices, and pars off through the Body.

To conclude ; Since now the own Body muft be confidered abftractly from any Humours and Juices, and fince all that ferves for the Food and Nourifhment of a Man-eater, muft only be divided from the vifble Body of the Perfon devoured; it is plain, that altho' a Canibal had devoured hundreds of vifible Bodies of other Men, it would likewife happen, according to the common Courfe of Nature, that the folid Particles divefted of all their Juices, or the owin Bodies of the devoured Perfons, would be difcharged, or caft out unmingled with thofe of the Devourer; and confequently that each of them might appear feparate and entire at the Time of its Refurrection.
$\mathrm{Sect}_{\mathrm{ec}}$ XXXIV. Convititions from all the foregoing Objections.
XXI. No w let an unhappy Atheilt ask himfelf feriounly, and in his Retirement, whether all thefe Objections which he is wont to fetch from Nature, can fecure him againft the poffibility of a Refurrection fo much dreaded by him? And if he argues without a Refolution of not believing the fame, whether thefe fudied Evafions can free his Mind from the continual Terrors that muft unavoidably follow the leaft Refletions of an

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 approaching Refurrection, and the Confiderations of appearing before the Judgment-Seat of that Juft and Almighty God, whom he has fo frequently, and fo unworthily Blafphemed ?

CONTEMPLATION XXIX. Of Unknoron Tbings.

## Sect. I. Tranjition to Unknown Things.

SINCE we have endeavoured in the foregoing Contemplations, to fhew from a very fmall part of what is known to us both in the great and littie World (and we hope likewife with unqueftionable Succefs) that there is fuch a Being as a Wife, Mighty, and Gracious God ; we might here put an end to this Work, were it not that even in thofe things which are ftill unknown, and which perhaps will remain for ever unknown to all Men, there did not feem to remain fome Proofs great and ftrong enough to bring unhappy Atheifts to a better Mind.

Sect. II. That there are many Things fill unknown.
IT will not be very neceffary to ufe many Arguments to prove, that there are an unexpreffible Number of Things in the Vifible World, as yet unknown to all Men. The different Opinions which prevail among the greateft and moft learned Men, about the Caufes of the fame Appearances, prove this Affertion plain enough; and one might
might well judge a Man very uncharitable, who when any one among thofe Learned Men had proved properly and experimentally the Truth of his Opinions, fhould think of all the reft, that they could be fo cinreafonable as to refure to comprehend, or fo fupid as not to be able to comprehend this Truth: At leaft this is certain, that if there be three Perfons of different Opinions, two of them, and it may be all three, know nothing of the matter. And, not to repeat here the Confeffions which great and famous Mathematicians have made of their Ignorance of many things, with a generous Self-denial (of which one may fee one Example in the thirteenth Hydrofatical Propofition of Dr. Wallis, and another in the eighteenth Optical Lecture of Dr. Barrow, Sect. 13.) let the proudeft and moft felf-conceited Atheift tell us, whether there is any real particular thing, fuch as the fmalleft Leaf of Grafs, or the moft contemptible Infect, that are perfectly known to him; and concerning which, numberlefs Queftions might be propofed to him, whereof he would be fearce able to anfwer any ; at leaft, could he tell us concerning one of thofe, or any other material Being, how the fmalleft and original Particles thereof are formed, how difpofed, how moved, and what fort of Pores or Interfices they make with one another? And even, not to go fo far, could he with all his Wifdom be able to fay, how a thing would appear through a good Microfcope, unlefs he had taken the pains before to examine the fame? And after all, fince there are fo many things which are quite out of the reach of the niceft Inquiry, one may eafily conclude, that in each of them there is a great deal that is wholly unknown to him. But this may fuffice here, fince I cannot imagine that there is any body who would pafs for wife or reafonable, that will not readily
readily own, there are many things of which be is entirely ignorant.

## Sec t. III. Atheiftical Objections anfwered.

I Know very well, that among there unhappy Men there are fome, who to elude the Proofs of a Wife God (the very Thoughts of which is dreadful to them) endeavour to fcreen themfelves againft the Reproaches of their convinced Minds behind thefe unknown things, faying, that if there be fill fo much unknown, how can we extol the Wifdom of a Great Creator, which can only manifeft itfelf in the things that are known? To anfwer which, before we proceed any farther, and for the Satiffaction of fuch as may fumble thereat, we affirm, Firf, That the Wifdom and Skill of an Artificer is not fo much difplayed by the number of Things he has made, as by the Contrivance and Workmanfhip that appears in each of them. For inftance, need we defire to fee any more than one Watch well made and skillfully put together, to judge of the Knowledge of the Maker? And if we fee but one compleat Picture of a Painter, will it not be fufficient to acknowledge him to be a great Mafter? Now if this be true, as it cannot be contradicted, I leave it even to the Atheift himfelf, whether he muft not own, that in the foregoing Difcourfes not one, but very many Inftances have been produced, of a Wifdom that governs the World ; and confequently, altho there be an infinite number of Things fill unknown, whether thofe which we now know are not abundantly fufficient to demonftrate the Wifdom of their Maker: The rather, fince that in knowing all thefe things, we know a great deal in refpect of others that have never inquired into, nor read the Difcoveries in Natural Philofophy; which, however, is very little,

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little, in comparifon of what remains to be fill known.

Secondly, Thefe Objectors muft be told, that a Man may be entirely ignorant of the Structure of a Machine, and of the Manner how it is put together, and yet not be the lefs fatisfied of the Art and Wifdom of him that framed it ; efpecially when one fees that it is accurately and nicely adapted to perform fome great and ufeful Defign. For can any body obferve a good Microfcope, confifting of two or three Glaffes, fo wonderfully contrived for viewing the very fmalleft Objects; or a noble Telefcope, made ufe of for the clear and diftinct contemplating the Heavenly Bodies, fo vaftly diftant from us, and confequently invifible to our naked Eyes; or a fine Clock, fhewing the Days, Hours and Minutes, and endued with feveral other Motions, and yet perfwade himfelf, that all thefe were made without any Skill or Contrivance, only becaufe the Structure and Difpofition of them are unknown to him?

Sect. IV. Unknown Things, tho' in themfelves not conceivable, do yet prove the Greatnefs of God.

If now it be obvious to every one, that from what has been faid about Unknown Things, even Reafon will teach us that God may be magnified thereby; the Wifdom of his Holy Word, tho' it were not allowed to be Divine, does likewife appear as plain from thence ; not only becaufe it does not make ufe of any Philofophical or Mathematical Demonftrations to prove the Power, Wifdom and Goodnefs of God ; but particularly, becaufe it makes ufe of things that are unknown to Men, and even unfcrutable, in order to convince us of the infinite Perfections of God, of the Mean-
nefs and Vilenefs of Man, and to flew the Reafons that we all have to praife Him and admire his Glory.

To give an Inftance thereof: Whether we fuppofe the World and all material Beings in it, to have been produced in the Beginning by the commanding Word of an Adorable Creator, as is confeffed by Chriftians; or whether, according to the Hypothefes of unhappy Atheifts (for higher than an Hypothefis they cannot pretend to go) it fhould be admitted, that if not the Form, yet the Matter of the World is Eternal: This at leaft will unqueftionably refult from each of thofe Hypothefes, that all the Particles of which all human Bodies are compofed, have exifted as long as the World, or as long as all Matter itfelf.

Now then no body can deny (becaufe it appears too plain by Experience) that all the Parts of our Bodies did at firft exift in the Food that has been made ufe of for the Growth and Increafe thereof, and confequently in Wheat, Rye, Barley, Rice, as alfo in the Flefh of Oxen, Sheep, all kind of Fowls and Fifhes, in the Fruits of all Trees and Plants, and, in one Word, in every thing that ferves to fupport the Life of Man. Confequently that they were likewife to be found in every thing from whence fuch Plants and Animals have been produced, that is to fay, in Earth, Water and Air; and thus tracing them ftill backwards, we meet with them in every thing whereof this very Earth, Water and Air confilts, namely of corrupted and putrified, burnt and confumed Bodies. So that if we go back from one thing to another, and follow this -Thread to the Beginning of the vifible World, muft not every one that ferioully confiders the fame, be convinced, that his Body, and all the Parts of which it. at prefent confifts, have inceffantly paffed from one

Mixture and Compofition to another, for as many Ages as the World has lafted; fo that thefe our Hands and Feet, and ail the Limbs we now poffefs, have, with refpect to their original confituent Particles, been difperfed and fcattered thro' infinitely different Places for thoufands of Years paft, growing in Plants upon the Ground, walking with Cattle in Meadows, flying with Birds in the Air, fwimming with Finhes in the Water, and plowed up in the Furrows of the Earth. And fince Water and Air likewife do bear a part in the Compofition of our Bodies, the Particles thereof which are now mixed with our own Flefh, have been exhaled out of Rivers, have afcended in Vapours, and defcended in Rain, Hail and Snow, have been kindled in Lightning and other Meteors, have been featter'd in Storms, and wafted backwards and forwards to all parts of the World by the Winds; and thus in numberlefs Places, at numberlefs Times, and after numberlefs Manners, have undergone numberlefs Compofitions and Mixtures, till they have been finally collected and become the conftituent Parts of thefe our Bodies.

Now tho' nothing of all this implies any Infinity, or any Incomprehenfibility ; yet the moft felf-conceited Atheift muft acknowledge, that neither he, nor any one elfe can ever be able to trace this his Genealogy or Pedigree; nor to fay in what Figure, in what Structure, or in what Places the Parts of his prefent Body have refided from the Beginning of the World; and that a greater Knowledge than that of all Men living, is requifite to return a proper Anfwer to this Queftion.

And the Almighty feems to have propofed much the like Queftion to Fob, to convince him in the ftrongeft manner of the Divine Glory and

Greatnefs, and of his own Vilenefs and Nothingnefs, in the following Words: Where waft thous when I laid the Foundations of the Earth? Declare, if thou baft Underftanding. Ch. xxxviij. v. 4 .

After the fame manner we find King David taking an occafion to praife God, and to acknowledge his Works to be wonderful, from the Things that were unknown to him, but manifeft to God alone. For after having confeffed his own Ignorance, and extolled the infinite Knowledge of God in thefe Words of the CXXXIXth Pfalm, Ver. 6. Such Knowledge is too wonderful for me; it is bigh, I cannot attain unto it ; he continues to fay, in the I4th and following Verfes, I will praife thees, for I am fearfully and wonderfully made. And, as if he did not thereby fufficiently acknowledge his own Ignorance, he adds, Marvellous are thy Works; and that my Soul knoweth right well. My Subfance (otherwife my Bones or Strength) was not hid froms thee whien I was made in fecret, and curioully wrought in the loweft parts of the Earth. Thine Eyes did fee my Subftance yet being imperfect, and in thy Book all my Members were written, which in continuance were fafbioned, when as yet there was none of them.

I fhould not have repeated thefe things here; having had occafion to fpeak of them more than once already, were it not that we find much the fame Expreffions about the Exiftence of a human Body, as are analogous and uniform to the various Obfervations and Difcoveries of the greateft Naturalifts of our Age: And that an Infidel may be fully convinced thereof, let him only read what the great Harvey writes thereupon, Exerc: 56. de Ord. Part. in Gen.

We thall find in the aforefaid Treatife, that even in the fecond Month, the whole Frame of the little Embryo is of fuch a fort of inconfiftent Subftance, that it cannot be touched without it we laid in Water. Let then the Atheift confider, Vox. III.
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whether King David had not reafon to fay, that he was fearfully made? And would he nor be frighted, in feeing how eafily his precious Body and the tender Limbs thereof may be fqueez'd to pieces, or turned to a mifhapen Creature, even by the Motion of the Mother's Bowels, and other Caufes ?

Secondly, The aforefaid Prophet fays alfo, that he is wonderfully made; and after the fame manner we hear the famous Philofopher Harvey expreffing himfelf with Amazement, Mirum dictu, or, 'tis wonderful to fay it, how far the Embryo or Fruit is in the fourth Month advanced in Bignefs, being grown from the length of an Inch to a Span.

Thirdly, The Pfalmift of Ifrael, who riames his firft Beginning an imperfect Subfance, could hardly exprefs this with more Emphatical Words than the abovementioned Author, when he tells us; that in the third Month the little Limbs begin to appear ; but he adds, Rudi tamen forma ; that is, in a rough or irregular Form ; infomuch that even the Mufcles could not be then diftinguifhed, tho' the Flefh, or greateft part of the Body be compofed thereof. And when he proceeds to defcribe an Embryo four Months old, he fays, that the Head of it was very large, the Face without Lips, Cheeks, or Nofe; that the Mouth was likewife very large, and the Tongue vifible therein, but the Eyes were fmall but without Eyelids; that the Flefh of the Forehead, which covered the whole Crown was not yet cartilaginous, far fhort of having acquired the Confiftence of Bones. Now what Atheift can fay, that the Holy Scriptures do not without Reafon compare the Origine of all Men to an imperfect Subfance? The rather, if we add thereto what Mr. Dodart fays in the Hiftory of the Academy of Sciencer, 1701 , p. 26. It is plain, that a Fœotus has wery different Proportions from thofe of a grotun Perfon;

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and that if the Limbs of a Man were made accordingly, they would be quite monftrous, and hardly pafs for buman.

Laftly, Thefe Expreffions, In thy Book all my Members were written, which in continuance were $f a$ fhioned when as yet there was none of them, Pf. cxxxix. v. 16. do fhew how well known to him that infpired the Holy Penmen, were thefe daily Changes of a Fotus, aftei the fame manner as they have been obferved in our Ages by the aforefaid Harvey and Malpighi, and as they have been defcribed in Birds by the latter from day to day.

To conclude then; Let an Atheift confider, from the few Paffages here quoted, and from a great deal more that he will find in the abovementioned Authors, how much is unknown to him of his own Formation, and how exceedingly he is beholden to that great Wifdom and Power which expanded him from the little Stamen and Clew in which he was roll'd, firft to an imperfect Subftance, and afterwards to fuch a noble and well-contrived Body, without the leaft Knowledge or Concurrence on his own part.

Sect. V. It is unknown, whether the Earth or the Sun moves.
If now (paffing by a great number of things that are fill unknown) we proceed in the laft place to give a famous Inftance of one more unknown thing, namely, whether the Sun or the Earth moves, and confequently to which of them we owe the Days and Nights, and the Seafons of the Year: I doubt not but it may appear very furprifing to many, and efpecially to thofe who without having taken the pains, or had an occafion experimentally to enquire into Aftronomy themfelves, do found the whole Structure of Na tural Philofophy upon this or that Hypothefis; tho' otherwife the greateft Mathematicians are fully convinced, that altho' there has been per-

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haps no other thing examined into with more Pains, Charge and Application, in order to know the fame with Certainty, yet nothing entirely pofitive can be advanced concerning it.

Sect. VI. Such Ignorance proceeds, Firft, from the Difagreement of great Aftronomers.
Now to fatisfy every unprejudiced Perfon of the Truth of what we have afferted, we fhall endeavour to proveit, Firft, from the Difagreement of the greateft Inquirers into this matter. Accordingly we find among the Ancients, that-Pbilolaus held one fide of the Queftion, and Ptolemy, the other ; and among the Moderns Tycho Brabé maintains, that the Earth ftands ftill, but Kepler that it moves, and both thefe were famous Aftronomers. It may be, the Reader will be furprifed that I have not mentioned the Great Copernicus; but the Reafon why I have omitted him is, becaufe we find that he himfelf was convinced, that nothing could be certainly laid down concerning this matter in his Time, as we fhall fhew more fully by and by. Others again fuppofe the Diurnal Motion of the Earth about its own Axis but an Annual Motion of the Sun, who are therefore called Semi-Tychonics; and they likewife do thereby account for all the prefent known Phænomena, as well as Copernicus and Tycho Brabé.

To fee this proved, we may confult Dr. Gregory's Aftronomy, at the Eleventh Part of the Firft Book, together with many more Authors, who have with great Skill and Judgment fhewn the Laws and Directions of the Motions whereby each of thefe three Hypothefes may be fupported.

Since then thefe great Men, from whom only one might expect a Determination of thefe Difagreements, fince they who have inquired into the Matter with fo much more Care and Application than others, do ftill differ fo much among themfelves
felves about the fame, can any one believe that they would not long fince have agreed in one and the fame Opinion, if ever it had been fully and rightly proved? the rather, forafmuch as we find that they do not make the leaft Difficulty to depart from the Opinions of Ptolemy, concerning the Orbits of Venws and Mercury (which he fuppofes to revolve about the Earth) as foon as ever the Experiments and Obfervations made by Telefcopes had taught them, that thefe Planets moved only abour the Sun, and by no means about the Earth; wherefore as long as this Difagreement lafts between the greateft Mathematicians, we may be pretty fure that no Body has been able to fee a folid Foundation of Truth in the Proofs produced by others; and confequently that other Arguments which only depend on the Obfervations of thofe, have not hitherto been able to prove any thing certain thereof.

S ec t. VIII. Secondly, Eecaufe great Aftronomers do themfelves own that they are uncertain about this Matter.
Secondly, This may likewife be inferr'd from hence, that the moft famous and moft skilful Afronomers, after having employed fo much Pains in this Inquiry, do freely and honeftly confefs, that they are fill entirely uncertain, concerning the Motion or Reft of the Earth ; which Confeffion is yet ftronger for this Purpofe, than their Difagreement.

And to the end that this may not feem incredible to thofe who have a higher Opinion of thefe Mathematicians, than they have of themfelves, we will quote fome of 'em, to witnefs the Truth of what is here advanced: Thus I remember, that having had the Honour to difcourfe with the great Mr. Huygens about other Matters, and asking him whether he could affirm any thing, with Cer-

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tainty, about the Earth's Motion; he was pleafed to anfwer, That it was his Opinion, that as long as we were uppon this Earth, no body could be able fully to prove the Jame.

Thus likewife we fee Sir IJaac Newton, tho' with Mr. Huygens, he commonly fuppoles the Earth to move, yet he mentions the Matter with great Caution, and without advancing any thing pofitively ; See Princip. Philof.p. 375 , of the fecond Edition, where it being affirmed, among the Hy potheres, that the Centre of the World is at Reft, and not moved; this Reafon is added, this is allowed on of all Hands, whilft at the fame time fome make the Earth, otbers the Sun, to be at Reft in the Ceintre of the World. We likewife find in the fourth Phenomenon, this Expreffion; Of the five Principal Planets, and (of the Surn about the Earth or) of the Eaith about the Sun, the Times of the Revolution are, \&c. and in the fourth Propofition of the faid third Book, towards the End, wè fee thfe Words, This Calcullation (which is of fome Moment) is founded on the Hypothefis of the Inmmobility of the Earith.

And can any one fpeak out more plainly hereupon, than the famous and so highly efteemed Mathematician, P. Herigonus; who in his Curfus Matbem. de Sphara Mundi, p. 53. ufes there pofitive Words, That the Earth in the Centre of the Firmament, or, that it is moved or not moved, cannot be proved by any Matbematical Demongfration.

And that we may know that other great Men do likewife 'rpeak doubtfully of the Earth's Motion, we need only read the laft Lines in $p .273$, of Dr. Gregory's AArronomy; where fpeaking of the Parallax of the fixed Stars with refpect to the Earth's Way, he thus conciudes, For afice this Manner they might put the Motion of the Earith out of doubt, which every one would owin is well woor th the while Ry which he fhews how uncertain that Matter fill is.

The Opinion of Mr. de la Hire, in the Preface to his Aftronomy, is likewife declared upon this Matter; that great Aftronomer faying, But after I had compofed fome Motions from the daily and yearly Motion of the Sun, or of the Earth, \&cc. from whence it plainly appears, that he durft by no means determine the Matter.

Thus we find in the Memoirs of the French Academy, 1707, p. 14. That Mr. Varignonhaving faid, that Ricciolus had given feveral Reafons for the Immobility of the Earth, and that de Angelis had returned an Anfwer to it, he the faid Mr. Varignon, far from determining which of 'em was in the Right, contented himfelf with declaring only, that be did not undertake to inquire into their Arguments; but fuggefted another Difficulty, which feems to render the Earth's Motion yet more uncertain.

If now down to this prefent Time, in which molt of thefe things have been written, one only foiid Proof, to determine whether the Earth moved or ftood ftill, had been known to thefe great Men ; can it be fuppofed that Perfons of their Learning, moit of whom form their Computations upon the Hypothefis of a moving Earth, would have fpoken fo doubtfully and uncertainly thereof.

Sect. VIII. Thirdly, Becaufe the Parallax from the Annual Motion is fill uncertain.
Thirdly, It is true that Mr. Flamftead is of Opinion, that he is able to prove, from his Obfervations, a Parallax of the fix'd Stars, and confequently that the Earth moves; but with how little Certainty, may appear from the place that we lately quoted out of Dr. Gregory's Aftronomy, to which Mr. Whifton has replied in Defence of Mr Flamftead: But this whole Difcovery feems. to be but of little Ufe for this Purpofe, chiefly from what we read of Mr. Caffmi, the younger, Uuน 4

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in the Trainfactions of the French Academy for the Year 1696. to which Mr. Whijton anfwering in his Pralect. Phyfic. Mathem. p. 202. (as much as he feems inclined to maintain the Certainty of the Earth's Motion from the above-mention'd Obfervations, for nothing certain can be concluded upon any other Principle) does confefs, that Mr. Flamftead does not argue right in every thing, as the French have lately obferved; and that he often deduces the Parallax of the fix'd Stars from the Phenomena, that do by no means prove the Jame; which in $\int a$ great an Aftronomer as be was, appeared very Atrange to him: Concluding with the following Words, after he had faid fomething which did not imply much Certainty; but this muft be left to the farther Diligence and Widdom of the Aftronomers. So that this Gentleman, who is otherwife wont to declare himfelf with very ftrong Expreffions againft thofe that maintain the Immobility of the Earth, does neverthelefs in this Cafe, as it appears from his own Words, finally leave the matter undetermined.

Now how little Hopes remain to find a Parallax of the fix'd Stars, whereupon to build with any Certainty, may be feen by Sect. XI. of the 3 d Book of Dr. Gregory's Aftronomy, and from the Cofmotheoros of Mr. Huygens, p. 134, \&c. fo likewife Sir 1 faäc Newton fays, Princip. Philof. Lib. 3. Sect 14. That the Stars have no remarkable Parallax proceeding from the Annual Motion of the Earth.
Sect.IX. Nothing can be injerr'd from the Expreffions ufed by great Aftronomers, about the Earth's Motion.
Now tho' the greatef Mathematicians of this Age are not afhamed freely to own their Uncertainty, as to the Motioiz or Reft of the Earth; yet there is another Sort of Philofophers, who being but little skilled in Afronomy; or Mathematicks,
do confidently and pofitively maintain, that the Earth moves; becaufe they cannot imagine that fo many, and fo great Men, fhould in their Writings and Calculations, fuppofe the fame, if they were not fully afliured thereof.

Now to convince them, that the Mathematicians themfelves do not always give credit to their own Hypothefes, there needs no more to be faid, but that it is fufficient for Mathematicians that they can moft conveniently deduce from thence the hitherto known Phenomena, without confidering, in the leaft, whether they be true or no: A great Proof thereof may be found in a certain kind of Preamble to the Book of the famous $\mathrm{CO}^{-}$ pernicus, the whole of which were worthy to be tranfcribed by us, had it not been too large. It is there faid, that it is not neceffary that the Hypothefes Sould be even probable, and that it is enough if the Culculations may be thereby made to agree with the Experiments. And afterwards, and fince various Hy pothefes are often adapted to one Motion, (as in the Courfe of the Sun an Excentricity and a Motion about the Center) an Aftronomer may chufe that which is moft eafly comprebended: A greater Probability may perbaps be required from a Philofopher, yet neither of them can be able to difcover any thing zuith Certainty, unlefs God reveals it to them. Whereupon finally, thefe emphatical Words follow: Let no Body, Jo far as it concerns an Hypotbefis, expect any thing certain from Aftronomy; fince it won't afford any thing like that, leaft by admitting for Truth that which is drefs'd up for other Purpofes, he Should leave this Science with greater Folly than be engaged in it. I don't know whether any one could more ftrongly confirm what has been faid before ; and I think that the foregoing Objections are fufficiently anfwered hitherto, by referring our Readers to the Authors of thefe feveral Books.

Thus we find in the Text of Copernicus himfelf, Lib. I. Cap. X. p. 20. That this great Aftronomer, inftead

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inftead of producing Reafons to fupport the Truth of his Hypothefis, contents himfelf with faying, Which I think we ougbte to admit more readily, than to puzzle and confound our Minds with an infinite Number of Circles.

After the fame manner fays $S$. Stevin, in the sth Propoftion of the Celeftial Appearances, with refpect to a moving Earth; That it does not appear neceffavily, that the Sun foould be in the Center of the fix'd Stars, but that it is allowed to be fo for good Reafons. And would you know his Reafons? they are the following : After having faid, that it may be fuppofed, but, according to his Opinion, not fully proved ; he concludes thus : But it is more convemient to allow the Sun to be in the Center of the World, becaufe other Phenomena may be more eafily and rationally folv'd therely.

Thus we hear the famous Kepler fpeaking in his Epitom. Afronom, p. $44^{88}$, and again 673 . When thefe Caufes are underflood, tho they be not believed, but only Juppofed, the Ufe thereef will be very eafy.

But the fame is very plainly made out by the Tranfactions of the Royal French Academy 1709. where Mr. Caffrit, after having fpoken of the Ufes, Properties and Advantages of old and new Hypothefes with great Learning, (but without maintaining the Truth of any of 'em) defcribes very curious Planetary Machines, all of which are founded upon the Suppofition of the Earth's Immobility. For which reafon likewife he places the fame immoveably, in the middle of thofe Ellipfes, which the Planets feem to revolve in, in the fpace of feveral Years, with regard to the Earth itfelf; and he even marks the appearing Revolution of the Sun about the Earth with a prick'd Circle. Now every Body knows, that altho' this great Aftronomer does here ufe the Hypothefis of an immoveable Earth, yet he does by no means affert the Truth thereo:; nay he fomerimes ufes a differen: ont.

From all which it appears, that thefe fo highly efteemed Mathematicians do more confider the Conveniency than the Truth of their Hypothefes in very many Cafes. But fince fome do pay fuch a blind Deference to their Science, that when they fee an Hypothefis ufed by Men of a great Name, they take it only upon their Credit ; therefore to convince thefe Gentlemen likewife, that we don't fpeak at random, when we affirm, that fuch a Mathematician does for the foregoing Reafons of conveniency advance an Hypothefis, which is not only abfolutely falfe, but even allowed to be fo by himfelf, we fhall prefent our Reader with a few Examples thereof.

Thus the Mathematicians do fuppofe imaginary Lines and Circles for the Conftruction of thofe fo ufeful Tables of Sines and Tangents, \& cr. and in thofe of Logarithms, that all Numbers are the true ones; whereas among Hundreds of them, there be very few that are really fo : For which Reafon alfo, and that the Difference between true and falfe may be the lefs, their way is to ufe fuch great Numbers.

So likewife Surveyors, or thofe that meafure Land, tho' they find fome Lines to be a little crooked, and fometimes go in and out in fmall Angles, yet they take them for ftrait ones; provided only that from the Suppofition of fuch a known Falfity a greater Convenience refults, and the Difference be not very confiderable.

Who does not know, that making the Degrees of Latitude larger and larger in Navigation, is nothing but a meer Fiction, and only that one may with more Conveniency make good the real Decreafe of each Degree of Longitude, though fuch ufeful and neceffary Tables are calculated upon the fame Foundation?

Though it be known to fuch as underfand $O_{P-}$ tics, that Spherical Glaffes never collect the Rays
$\mathrm{i}_{\text {nto }}$ a Point, (excepting in one or two Cafes) as Glaffes of fome other Figures do: Yet how common a Thing is it in the making of Telefcopes or Microfcopes, to fuppofe the fame, contrary to Truth ; and the Demonftration of the Practical Part is founded thereupon, even by fuch as know that this is a manifeft Falfity in the Theory?
What is more common than to fuppofe in Statics, that two Plumets fall down in frait Lines parallel to each other, whereas they would notwithftanding both meet at the Centre of the Earth ?

In, like manner, and upon the fame Foundations, 'tis fuppofed by Gunners, and even by thofe famous Mathematicians that write upon the Art of throwing Bombs, that their Balls by the Force of the Powder, and their own Gravity, do defrribe a Line, which they call a Parabola; whereas if they confidered the Refiftance of the Air, and other Caufes aforemention'd, they would know that the Properties thereof were very different.

In Dialling, we fuppofe the Center of the Earth, or rather of the Sun's Courfe, to be always at the Top of the Perpendicular Style (when the Shadow of it, as a Nodus, fhews the Hour) wherefoever the Dial be plac'd upon the whole Earth, though every Body knows it to be contrary to the Truth.

Thus all the ancient and modern Aftronomeris have always taken it for a Foundation of their Calculations, that the true or apparent daily Motion of the Sun is in a Circle parallel or equally diftant from the Equinoctial, notwithfanding that this Line, by the intermixing of the Sun's or Earth's Annual Courfe, comes nearer to a Screw or Spiral Line, than a Circle, as is well. known to the Aftronomers.

After having fhewn all this in fo many Branches of the Mathematicks, I don't think that a more exprefs
exprefs Demonftration will be required, to make appear, that altho' fome of the chiefeft among the Aftronomers do fuppofe either the Motion or Reft of the Sun, and found their Calculations thereupon, yet this does not in the leaft fhake either the one Hypothefis or the other: Since, provided the Miftakes be not of too great Importance, they frequently make ufe of Hypothefes for Convenience fake, which they themfelves know to be falfe.

> Sect. XI. The Simplicity of an Hypothefs is not always an Argument of its Truth.

There is yet one Argument from whence fome People do conclude a little too haftily, that the Hypothefis of the Earth's Motion is true; namely, becaufe it appears to them the more fimple of all: And for farther Proof, fay, that it is moft becoming the Wifdom of the great Creator, to bring about the greateft Matters after the moft fimple Manner.

We fhall not here enter into a large Difcuffion about the Weaknefs of this Characterftic; fince no Body can know when a Machine is fhewed to him, whether it be the moft fimple or no, unlefs all the Views and Ends of him that invented it were at the fame time difciofed to him, which none will prefume to affirm concerning the StruCture of the vifible World: For upon this Foundation, thofe who maintain the Sun's or the Earth's Orbit to be Circular, contrary to experience, might juftly alledge, that their Opinion had more Truth in it than that of thofe who maintained the fame to move in an Ellipfe or oval Figure: Forafmuch as beyond all difpute the Figure of a Circle is more fimple than that of an Ellipfis.

But to come a little clofer; let fuch as maintain this, tell us what is the Reafon why all Aftrono-

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 mers, at leaft all that $I$ know, and among whom there are likewife many that zealoufly contend for the Earth's moving, and the Sun's flanding ftill, as Copernicus himfelf, and fince him Kepler, Lantsberg, and in our time, the North-Hollander Richard Rembranten van Nierop; tho' all of them do in the Theory, or annual Courfe from Eaft to Weft, maintain the Hypothefis of a moving Earth, (for as much as the Calculations are much more convenient according to them in this Cafe) yet in erery thing that belongs to the Spharics, or daily Revolution from Eaft to Weft, they are wont to make their Figures and Calculations directly contrary to their own Notions, upon the Foot of a moving Sun and a refling Earth, tho' they commonly fart the greateft Objections againft this laft.Of what has been faid, there is no farther Proof neceffary, fince this is apparent to every Body in almof all Figures that are ufed by them to this Parpofe; in which they are even wont to exprefs the Parallels in which the Sun daily moves, and to call them by that Name. It feems to me likewife to be particularly remarkable, that Mr. Whijfon himfelf, who is otherwife fo great a Champion for a moving Earth, does tranfcribe the Demonftration of the Manner after which Mr. Cafini has fo ingenioully obferved the Parallax of the Planets, into his Pralect. Afron. p. 75, $\sigma_{c}$. with fo great refpect from the Act. Lipf. 1685, almoft in the Words of Mr. Blanchini; notwithflanding that the fame is formed upon the Hy pothefis of a fix'd Earth, and the daily Revolution of the fix'd Stars and Planets, fhe wing what he himfelf terms it, The daily Revolution of Mars in a Circle, and often ufing this Expreffion, That Mars and the fix'd Stars are moved and carried round about by the Diurnal Motion.

We might produce many more Infances here, to fhew how little Account is made of all Hypothefes; but having dwelt fo long upon this Matter aiready, we choofe rather to refer our Reader to the Preface of Mr. de la Hire's Aftronomy; there is likewife fomething faid about the fame in our Introduction. Sect. XVI.

Sect. XII. A Conclufion from the Whole, that neither the Sun's nor the Earth's Motion has ever been rightly proved.
Now to come to a Conclufion from what has been hitherto faid of the Motion or Reft of the Earth.
I. Since the greateft Men do ftill differ upon this Point, and no Body has yet been ever able to produce a fix'd and folid Proof of the Truth on one Side or the other. (Sect: VI.)
II. Since fuch famous Mathematicians and principal Aftronomers as Huygens, Newton; la Hire, Varignon, (to whom few will dare to compare themfelves in the Knowledge of Aftronomy, without being thought very prefumptuous and conceited) and fo many other have ingenuoufly, confeffed their uncertainty in this Matter, tho' they are of the moft modern; fome of them being ftill alive, and all till lately ; and confequently have had the beft Opportunities that can be yet procured of examining into every Thing that has been difcovered conceraing the fame. (SeEz. VIII.)
III. Since the hopes of finding out the $p_{a-}$ rallax, and diftance of the fix'd Stars from the Earth, are very fmall, by which otherwife the Matter might be determined after a good, if not the beft manner. (Sect. IX.)
IV. Since we cannot find any Demonftration of the Proof upon it, becaufe very learned Men have indifferently made ufe of the one or the other

Hypothefis; forafmuch as in almoft all the Branches of Mathematicks, Hypothefes are ufed not to thew how the Thing is really in it felf, but only in order to deduce from thence the known Phanomena with the greateft Convenience, and with the leaft fenfible Difference; fo that even Things that are known to be entirely difagreeing with Truth, are frequently fuppofed, for the aforefaid Reafons, even by the greaft Men that treat of Mathematical Matters. (SecZ. X.)
V. And laftly, fince the fame Mathematicians do one while make ufe of this Hypothefis, another while of that, according to their Convenience in prefent Cafes, or for the eafe of their Calculations, or for the better Conception thereof, or Defcription of them by Figures in the mof plain and fimple manner. (Sect. XI.)

Let every Body confider with himfelf, whether he can be perfwaded, that there will ever be difcovered any folid or proper Proof, fuch as may be fufficient experimentally to convince Men, that the Motion or Reft of this Globe of the Earth is demonfrable, clearly and plainly, and to the Satisfaction of true Mathematicians: At leaft if any one fhould pretend to affert this, it would be the fame thing as if he fhould declare, that all thofe great and learned Aftronomers a-bove-named, have been either fo ignorant as not to be able, or fo malicious as not to be willing to underftand fuch a Proof; which any Man who is juft and reafonable, muft think to be the greateft Ablurdity.

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